Of this issue more than 4000 copies were printed

The Welding Engineer

Vol. 1 | Chicago 608 S. Dearborn St. | JUNE, 1916 | $2.00 per year in U. S. $2.50 per year abroad | No. 6

Industrial Preparedness Means Mental Preparedness

THERE never was a time when the specialized trade paper was as greatly needed by manufacturers as right now. Industrial preparedness is the watchword, meaning nothing more or less than efficiency. To be efficient, one must study one's work—prepare to do the work better and cheaper. Be mentally prepared, in fact, and from a welding standpoint, that means good literature on the subject.

Metal working industries, railroad shops, automobile manufacturers, shipbuilders, car manufacturers, foundries, steel makers, etc., find The Welding Engineer a link in the chain of industrial preparedness. To be efficient in the welding department necessitates all of the information available on the subject of welding.

No other trade paper could possibly give the same attention and care to the subject of welding as The Welding Engineer. Its progress since the first issue has been remarkable, and today the majority of the leading manufacturers in this field are advertisers. On the other hand more than 4000 readers receive every issue—the very class of buyers the manufacturers would like to reach.

The Welding Engineer is a member of the Audit Bureau of Circulations. That means we are "out in the open." Send for a copy of the Bureau's Audit of our circulation. It's a form of insurance we carry for our advertisers.

L. B. Mackenzie

COVER SPACE

We have some first cover space available. Price $150 per issue. If you are interested we would be glad to talk it over with you.

*Alphabetical Index to Advertisers and Buyers' Index, Page 4.

The largest makers of Oxy-Acetylene Welding and Cutting Equipment and Supplies in the World

Oxweld Equipment includes Acetylene Generators, Welding and Cutting Blow Pipes, Regulators and Supplies—everything needed for all requirements—complete installations for the most extensive manufacturing and repair operations to portable units for emergency and field use. Because of the scientific accuracy and exactness of design—high quality materials and the mechanical perfection of construction and workmanship, **OXWELD EQUIPMENT** will produce the most efficient and economical results in welding and cutting operations of every character.

Oxweld Supplies are made up in accordance with the formulae of our metallurgists—tested by analysis in our laboratory and their merits tested out and proven by our expert welders in actual shop practice. We guarantee **OXWELD SUPPLIES,** when used by competent welders, to produce better results than any others known to the art today.

Our knowledge and experience, as the largest makers of welding and cutting equipment in the world, are always at the service of every purchaser and prospective purchaser of **OXWELD APPARATUS,** to determine the most economical and efficient applications of the **PROCESS** to the manufacturing or repair problems at hand.

Write us for information on any class of Welding or Cutting Work

Oxweld Acetylene Company

CHICAGO
36th St. and Jasper Place

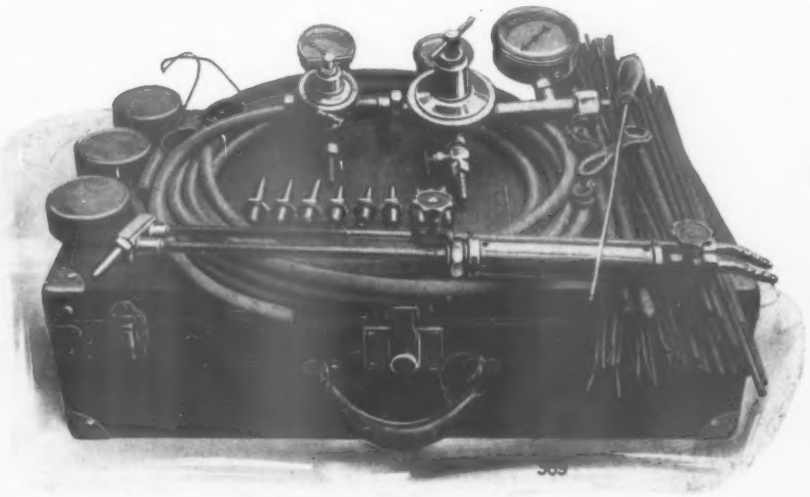
NEWARK, N. J.
6460-680 Frelinghuysen Ave.

LOS ANGELES
654-656 Pacific Electric Bldg.

The BUCKEYE Oxy-Acetylene Welding and Cutting Outfits

Stationary and Portable

We Build Preheating Kerosene Torches and Oil Furnaces



Live Men Wanted to Represent Us in Territory Not Allotted Only Men Who Will Demonstrate Desired

We Build Both Oxygen as Well as Acetylene Generators

Ask for Catalog K

THE MACLEOD CO., East Pearl Street, CINCINNATI, OHIO

Wrecking Huge Electric Plant!

The gigantic task of dismantling the huge abandoned Harrison Street Plant of the Commonwealth-Edison Company in Chicago is being accomplished in record breaking time by means of four outfits of

IMPERIAL WELDING CUTTING EQUIPMENT

OXY-ACETYLENE PROCESS

Mammoth engines, generators, fly-wheels, forty-two 350 h. p. boilers, coal hoppers—seemingly immovable, have been reduced to small, easily handled pieces of scrap, as if by magic, by the Imperial Cutting Torch.

The illustration shows a 24 foot fly-wheel in which the steel keys, 10 inches thick, were quickly cut although the sockets in which the keys were placed rendered the working conditions extremely severe.

Get our new catalog, telling all about the many exclusive advantages of Imperial Equipment, cost of operation and other valuable data.

Imperial Brass Mfg. Co.

522 So. Racine Ave. Chicago

Buyers' Index

Readers of the Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Commercial Acetylene Railway Light & Signal Co.
The Prest-O-Lite Co., Inc.
Universal Oxygen Co.

ACETYLENE GENERATORS
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
International Oxygen Co.
The Macleod Co.
Metals Welding Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.

ALUMINUM FILLER RODS
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
Superior Oxy-Acetylene Mach. Co.
United States Welding Co.
Universal Oxygen Co.
Welding Materials.

ALUMINUM FLUX
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Welding Materials.

ALUMINUM SOLDER
Imperial Specialty Sales Co.

ANNEALING FURNACES
Buffalo Dental Mfg. Co.
The Macleod Co.
Universal Oxygen Co.

APRONS (Asbestos)
Welding Materials.

ASBESTOS GLOVES
Welding Materials.

ASBESTOS SHEET PAPER
American Oxygen Co.
Davis-Bournonville Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Welding Materials.

BLOW TORCHES (Acetylene)
American Oxygen Co.
Bermo Welding Apparatus Co.
Buffalo Dental Mfg. Co.
Indiana Oxygen Co.

BOOKS (Relating to Welding)
The Welding Engineer

BRASS AND BRONZE FLUX
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Indiana Oxygen Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Welding Materials.

BRASS SPELTER WIRE
Universal Oxygen Co.
Vulcan Process Co.

BRAZING OUTFITS
Buffalo Dental Mfg. Co.
Superior Oxy-Acetylene Machine Co.
The Macleod Co.

BRONZE FILLER RODS
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Welding Materials.

BUTT WELDERS (Electric Resistance)
Thomson Electric Welding Co.
Welding Materials.

CARBIDE (Calcium)
American Carbolite Sales Co.
Union Carbide Sales Co.
Canada Carbide Sales Co.

CARBON REMOVING TORCHES
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Federal Brass Works
General Welding & Equipment Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Indiana Oxygen Co.
The Macleod Co.
Metals Welding Co.
Oxy-Acetylene Products Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Mach. Co.
Universal Oxygen Co.

CAST IRON FILLER RODS AND FLUX
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Welding Materials.

ELECTRIC ARC WELDING OUTFITS
Westinghouse Electric & Mfg. Co.
Welding Materials.
General Electric Co.

ELECTROLYTIC OXYGEN PLANTS
International Oxygen Co.
Universal Oxygen Co.

FILLER RODS (Aluminum)
Oxy-Acetylene Products Co.
United States Welding Co.

FILLER RODS (Swedish Iron)
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Welding Materials.

FILLER RODS (Tobin Bronze)
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Welding Materials.

FILLER RODS (Vanadium Steel)
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Welding Materials.

FIREPROOF PLASTIC
Bermo Welding Apparatus Co.

FLUE WELDERS (Electric Resistance)
Thomson Electric Welding Co.

FLUX WELDERS (Electric)
Westinghouse Electric & Mfg. Co.

FURNACES (Annealing)
Buffalo Dental Mfg. Co.
The Macleod Co.
Universal Oxygen Co.

GASOLINE PREHEATING FURNACES
Buffalo Dental Mfg. Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.

GAS BURNERS (Preheating)
The Macleod Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Westinghouse Electric & Mfg. Co.
Superior Oxy-Acetylene Machine Co.

GLOVES (Asbestos)
United States Welding Co.
Welding Materials.

GOGGLES AND HOODS (Welders)
American Oxygen Co.
William C. Adams.
Bermo Welding Apparatus Co.
Chicago Eye Shield Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Westinghouse Electric & Mfg. Co.
Welding Materials.

GLOVES (Welders Asbestos)
American Oxygen Co.
Davis-Bournonville Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Universal Oxygen Co.

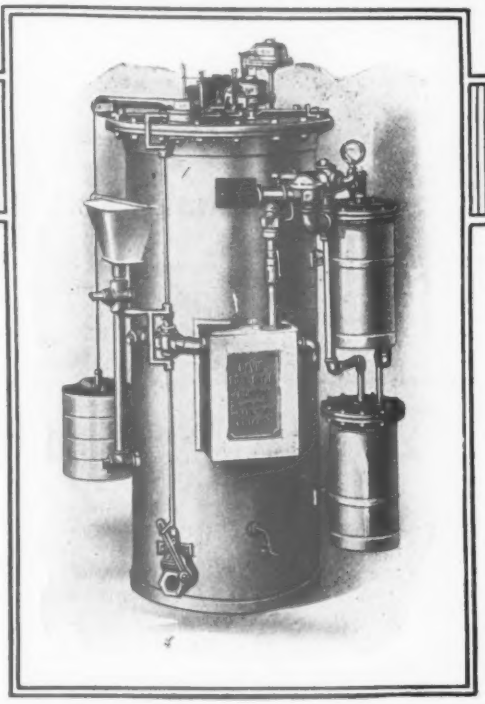
GAUGES (Pressure)
American Oxygen Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Federal Brass Works.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Indiana Oxygen Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
United States Welding Co.
Universal Oxygen Co.
U. S. Gauge Co.

HARDENING FURNACES
Buffalo Dental Mfg. Co.
The Macleod Co.

DAVIS-BOURNONVILLE CO.
DAVIS
APPARATUS
NEW YORK - CHICAGO

ACETYLENE
For Welding and Cutting

IT may be generated on the premises at low cost for oxy-acetylene welding and cutting, or may be bought in portable tanks or cylinders. We sell both portable and stationary outfits, and recommend that which the customer can use most efficiently and most profitably. It is to *our* interest as well as *his* for him to get the best results.



Davis Acetylene Pressure Generator No. 50. Made in 5 sizes—25, 50, 100, 200 and 300 lbs.

The remarkable success of oxy-acetylene welding with its value to metal working trades, was made with acetylene generated on the premises.

Those concerns making the greatest use of the process and who have established the greatest confidence in its efficiency, use acetylene generators—generating the gas on their own premises as wanted, piping it directly to welding or cutting stations. Many such concerns have two, three or four Davis generators of the largest size, connected in series, some running night and day. Hundreds of general repair shops are equipped with small generators for their shop work and portable tanks for their field work, thereby obtaining full measure of efficiency and economy. Acetylene can be safely generated on the premises with an approved generator at a cost much less than for compressed acetylene in portable tanks—it can be produced as it is required, under suitable conditions for the highest grade welding or cutting, and avoiding the chance of running out of gas when it is most wanted.

If the customer's work is such as to require portable apparatus, or if only a limited amount of gas is required, or only occasionally—portable tanks will best meet his requirements, and we will advise him of the most accessible supply.

The Davis Acetylene Pressure Generator is made in *five sizes* of standard pressure generators, *three sizes* of two-pressure navy-type generators, and *two sizes* of portable generators mounted on trucks.

	CARBIDE CAPACITY			GAS PER HOUR	No. of Hours*	TOTAL GAS
	Portable	Standard	Navy-Type	Cu. Ft.*		Cu. Ft.*
No. 25	25 lb.	25 lb.	.....	25	4½	112½
No. 50	50 lb.	50 lb.	.....	50	4½	225
No. 100	.....	100 lb.	100 lb.	100	4½	450
No. 200	.....	200 lb.	200 lb.	200	4½	900
No. 300	.....	300 lb.	300 lb.	300	4½	1350

*The rules and regulations of the National Board of Fire Underwriters provides that an acetylene generator shall be of sufficient capacity to supply gas to all torches in use from one full charge of carbide for a full working period of one-half day, or four to five hours, with a normal output of 1 cu. ft. of gas per hour per pound of carbide. In determining charges, lump carbide to be estimated as capable of producing 4½ cu. ft. of gas to the pound.

The Davis generator was the first one designed and provided with independent power for automatically feeding carbide to water to supply acetylene under pressure up to 15 pounds for use with the oxy-acetylene process. It was the first pressure generator inspected by the Underwriters' Laboratories and listed by the National Board of Fire Underwriters. Its reputation has been established by many years of most successful operation and *there are more Davis generators in use for oxy-acetylene welding and cutting than of any other make.*

DAVIS-BOURNONVILLE COMPANY

NEW YORK **CHICAGO**

General Offices and Factory, Jersey City, N. J.

SALES OFFICES: New York Chicago Detroit Cleveland Pittsburgh Philadelphia Boston

HOSE (Oxygen and Acetylene)

American Oxygen Co.
Bermo Welding Apparatus Co.
Buffalo Dental Mfg. Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

HOSE UNIONS

Bermo Welding Apparatus Co.
K-G Welding & Cutting Co.
Superior Oxy-Acetylene Machine Co.

HYDROGEN

International Oxygen Co.
Universal Oxygen Co.

KEROSENE PREHEATING TORCHES

Goldschmidt Thermit Co.
The Imperial Brass Mfg. Co.
The Macleod Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.

NEEDLE VALVES

Bermo Welding Apparatus Co.
Buffalo Dental Mfg. Co.
K-G Welding & Cutting Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.

OIL BURNERS (Preheating)

The Macleod Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Mach. Co.

OXYGEN (Compressed in Cylinders)

The Linde Air Products Co.
Superior Oxygen Co.
Swift & Co.
Universal Oxygen Co.

PIPE WELDING

Goldschmitt Thermit Co.

PHOTOGRAPHS

Chicago Architectural Photographing Co., (Specialists in photographs relating to the welding industry)

PLASTIC (Fireproof)

Welding materials.

PRESSURE GAUGES

The Bastin & Blessing Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Federal Brass Works
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
International Oxygen Co.
F. C. Kuhnle & Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
Superior Oxy-Acetylene Mach. Co.
U. S. Gauge Co.
United States Welding Co.
Universal Oxygen Co.

RAILROADS—Special Service for

Oxweld Railroad Service Co.

REGULATING VALVES (Acetylene)

The Bastin & Blessing Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Federal Brass Works.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
F. C. Kuhnle & Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
The Prest-O-Lite Co., Inc.
United States Welding Co.
Universal Oxygen Co.

REGULATING VALVES (Hydrogen)

The Bastin & Blessing Co.
Bermo Welding Apparatus Co.
Federal Brass Works
The Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
F. C. Kuhnle & Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.

REGULATING VALVES (Oxygen)

American Welding Co.
The Bastin & Blessing Co.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Federal Brass Works
The Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
F. C. Kuhnle & Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

SEAM WELDERS (Electric)

General Electric Co.
Westinghouse Electric & Mfg. Co.

SEAM WELDERS (Electric Resistance)

Thomson Electric Welding Co.

SPOT WELDERS (Electric Resistance)

Thomson Electric Welding Co.

TANK CONNECTIONS (Oxygen and Acetylene Adaptors)

Superior Oxy-Acetylene Machine Co.

THERMALENE-GAS

The Thermalene Co.

THERMIT WELDING

Goldschmidt-Thermit Co.

TORCHES (Gasoline and Kerosene Preheating)

Buffalo Dental Mfg. Co.
Federal Brass Works
General Welding & Eq. Co.
The Macleod Co.
Metals Welding Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Westinghouse Electric & Mfg. Co.

TORCHES (Oxy-Acetylene Cutting)

Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Federal Brass Works
General Welding & Eq. Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Metals Welding Co.
The Macleod Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.
The Thermalene Co.
United States Welding Co.
Universal Oxygen Co.

TORCHES (Oxy-Acetylene Welding)

Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Federal Brass Works
General Welding & Eq. Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
The Macleod Co.
Metals Welding Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.
The Thermalene Co.
United States Welding Co.
Universal Oxygen Co.

TORCHES (Oxy-Hydrogen Cutting)

Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Federal Brass Works
General Welding & Eq. Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Metals Welding Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.

TORCHES (Oxy-Hydrogen Welding)

Bermo Welding Apparatus Co.
Buffalo Dental Mfg. Co.
Davis-Bournonville Co.
Federal Brass Works
General Welding & Eq. Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Metals Welding Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
United States Welding Co.
Universal Oxygen Co.

TORCHES (Special to Order)

Bermo Welding Apparatus Co.
Superior Oxy-Acetylene Machine Co.

TRUCKS (Cylinder Carriers)

Davis-Burnonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

VALVES (For Oxygen Cylinders)

International Oxygen Co.
Universal Oxygen Co.

WELDING (Electric Resistance-Custom Work)

Thomson Electric Welding Co.

WELDERS' GOGGLES

William C. Adams.
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Welding Materials.

WELDING (Oxygen for)

International Oxygen Co.
The Linde Air Products Co.
Universal Oxygen Co.

WELDING TORCHES (Oxy-Acetylene)

Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Federal Brass Works
General Welding & Eq. Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
The Macleod Co.
Metals Welding Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
The Prest-O-Lite Co., Inc.
Superior Oxy-Acetylene Machine Co.
The Thermalene Co
United States Welding Co.
Universal Oxygen Co.

WELDING TORCHES (Oxy-Hydrogen)

Bermo Welding Apparatus Co.
Buffalo Dental Mfg. Co.
Davis-Bournonville Co.
Federal Brass Works
General Welding & Eq. Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Metals Welding Co.
Oxweld Acetylene Co.
Oxy-Acetylene Products Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

ALPHABETICAL INDEX TO ADVERTISERS

A

Adams, William C..... 12
American Carbolite Sales Co..... 12
American Oxygen Co..... 16

B

The Bastin-Blessing Co..... 10
Bermo Welding Apparatus Co..... 12
Buffalo Dental Mfg. Co..... 15

C

Canada Carbide Sales Co..... 15
Chicago Eye Shield Co..... 11
Commercial Acetylene Railway Light & Signal Co..... 37

D

Davis-Bournonville Co..... 5

G

General Welding Equipment Co..... 11
General Electric Co..... 8
Goldschmidt Thermit Co.....Back cover

F

Federal Brass Works..... 17

H

Henderson-Willis Welding & Cutting Co... 14

I

Imperial Specialty Sales Co..... 41
Imperial Brass Mfg. Co..... 3
International Oxygen Co..... 13

K

F. C. Kuhnle & Co..... 15
K-G Welding & Cutting Co., Inc..... 12

L

Linde Air Products Co..... 7

M

Macleod Co., The..... 3
Metals Welding Co..... 33

O

Oxweld Acetylene Co..... 2
Oxweld Railroad Service Co..... 11
Oxy-Acetylene Products Co..... 16

P

Prest-O-Lite Co., Inc..... 18

S

Superior Oxygen Co..... 43
Superior Oxy-Acetylene Machine Co..... 41
Swift & Co..... 14
Oxygen.

T

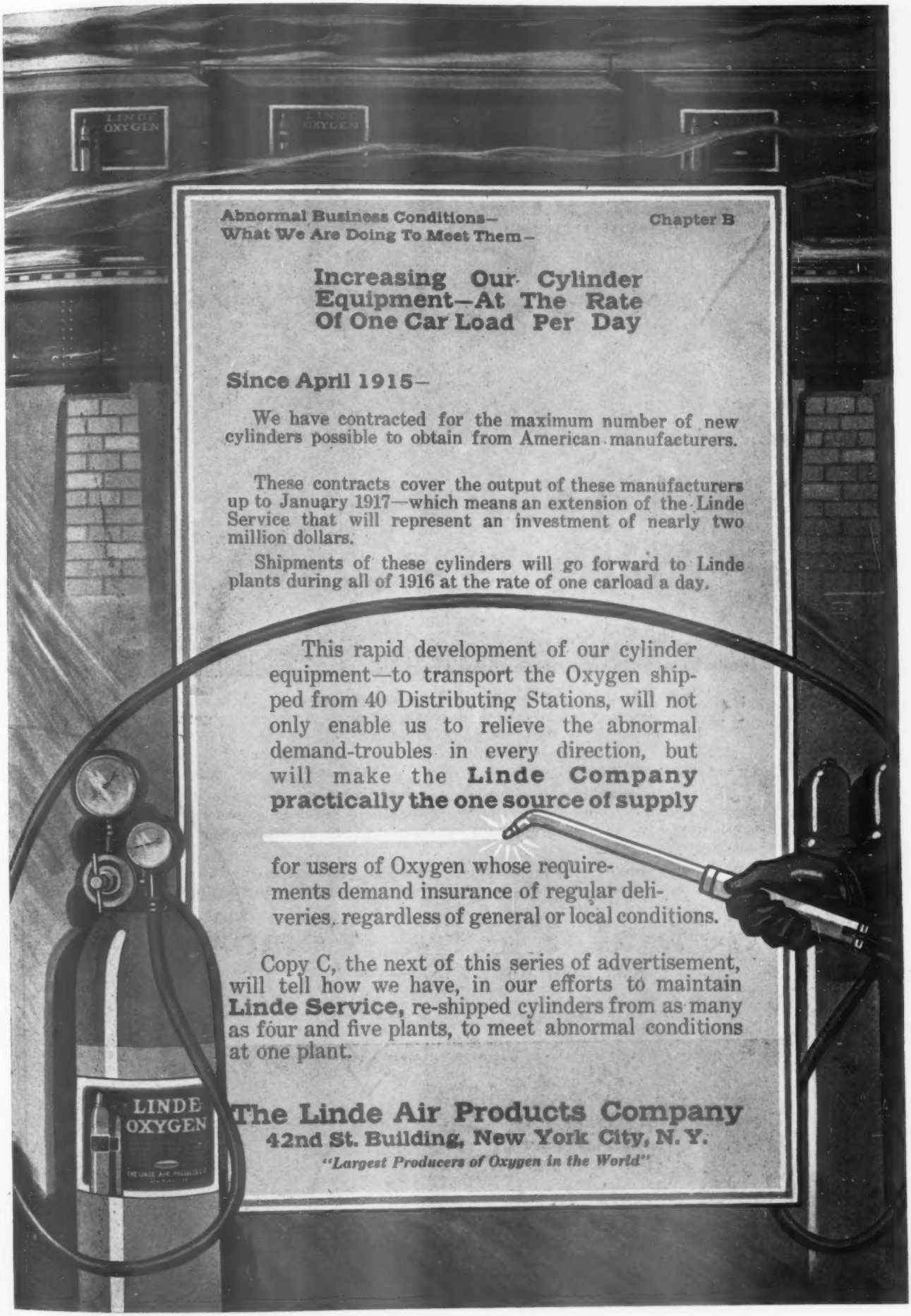
The Thermalene Co..... 10
Thomson Electric Welding Co..... 17

U

Union Carbide Sales Co..... 9
United States Welding Co..... 16
Universal Oxygen Co..... 13
U. S. Gauge Co..... 19

W

Westinghouse Electric & Mfg. Co.....
Welding Materials..... 1



Abnormal Business Conditions—
What We Are Doing To Meet Them—

Chapter B

Increasing Our Cylinder Equipment—At The Rate Of One Car Load Per Day

Since April 1915—

We have contracted for the maximum number of new cylinders possible to obtain from American manufacturers.

These contracts cover the output of these manufacturers up to January 1917—which means an extension of the Linde Service that will represent an investment of nearly two million dollars.

Shipments of these cylinders will go forward to Linde plants during all of 1916 at the rate of one carload a day.

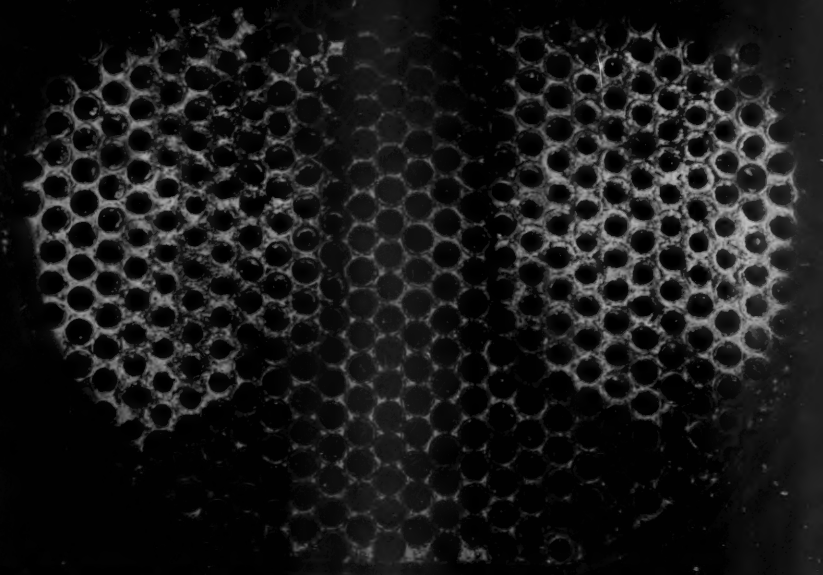
This rapid development of our cylinder equipment—to transport the Oxygen shipped from 40 Distributing Stations, will not only enable us to relieve the abnormal demand-troubles in every direction, but will make the **Linde Company practically the one source of supply**

for users of Oxygen whose requirements demand insurance of regular deliveries, regardless of general or local conditions.

Copy C, the next of this series of advertisement, will tell how we have, in our efforts to maintain **Linde Service,** re-shipped cylinders from as many as four and five plants, to meet abnormal conditions at one plant.

The Linde Air Products Company
42nd St. Building, New York City, N. Y.
"Largest Producers of Oxygen in the World"

Carbon electrode used for cutting or heavy current welding



Metal electrode builds up or fills cavities when welding

Light portions show welded tube ends in locomotive

BENEATH the C & O locomotive illustrated above, which has welded seams and flue sheets, is shown a partly completed locomotive flue sheet. The light portions show flue ends which have been welded by a G-E arc welding outfit, one type of which, used by the American Locomotive Company, is shown at the bottom of this page.

This welder does its own chipping, so work can go on when your chippers are busy elsewhere. The control of heat and building of metal possible with this welder prevents distortion, uneven crystallization and cavities.

A G-E arc welder will repair worn or broken parts while they are in place. Our nearest office will be pleased to give you additional information.

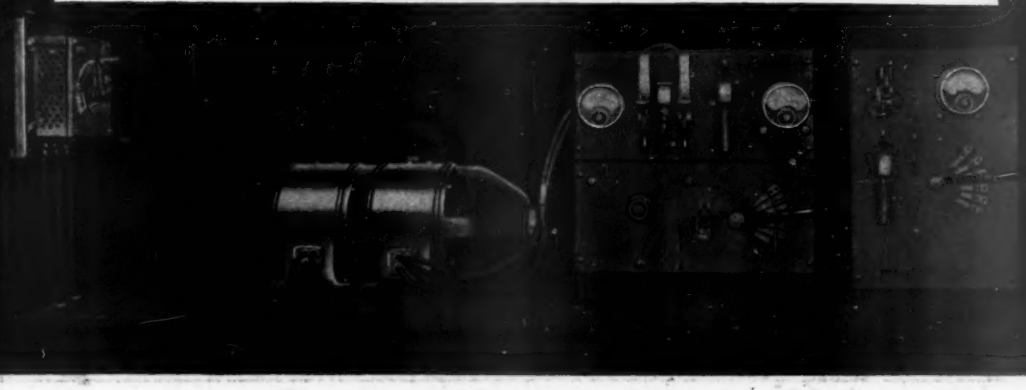
General Electric Company

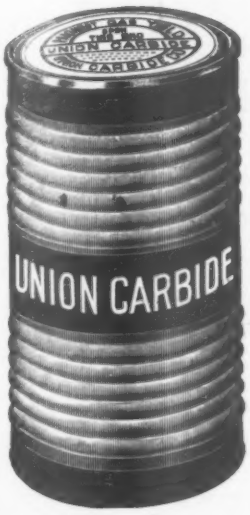
General Office: Schenectady, N. Y.

District Offices in:

Boston, Mass. New York, N. Y. Philadelphia, Pa. Atlanta, Ga. Cincinnati, O.
Chicago, Ill. Denver, Colo. San Francisco, Cal. St. Louis, Mo.
Sales Offices in all Large Cities

6242





Packed Gray Drums

Union Carbide Sales Company

New York City, 42nd St. Building | **Chicago, Ill., Peoples Gas Building** | **San Francisco, Cal., Kohl Building**

SOLE DISTRIBUTORS OF

UNION CARBIDE

"World's Best Quality—Highest Gas Yield"

For Oxy-Acetylene Welding Plants

Contractors' Flare Lights, Torches and Private and Municipal Lighting Plants

"Union Carbide" is packed in 100-lb. blue and gray drums marked conspicuously, "UNION CARBIDE."

The following sizes are carried in stock in 100-lb. drums:

$3\frac{1}{2}$ x 2 in. —a large size.

$1\frac{1}{4}$ x $\frac{3}{8}$ in. —an intermediate size.

2 x $\frac{1}{2}$ in. —a medium size.

$\frac{1}{4}$ x 1/12 in. —finely crushed size.

Union Carbide in the Generator sizes above listed will be shipped direct to consumers from a **Union Carbide Sales Co.** warehouse at any one of the following points where large stocks are kept on hand:

ALABAMA
Birmingham—1916 Morris Ave.
Mobile—262-268 S. Water St.
Montgomery—114 N. Perry St.
ARIZONA
Phoenix—16 S. Central Ave.
CALIFORNIA
Eureka—109 Second St.
Fresno—932 H St.
Los Angeles—639 Gibbon St.
Sacramento—1523-31 Front St.
San Diego—326-336 Fifth St.
San Francisco—Kohl Building.
COLORADO
Denver—Nineteenth and Wazee Sts.
Victor—Third and Diamond Sts.
CONNECTICUT
Hartford—877 Main St.
DISTRICT OF COLUMBIA
Washington—Maryland Ave. and 9th St., S. W.
FLORIDA
Jacksonville—106 E. Forsyth St.
Tampa—418 Tampa St.
GEORGIA
Atlanta—Cor. Haynes and Rhodes Sts., P. O. Box 1594.
Savannah—Ogeechee Canal, South of Bay St., P. O. Box 78.
ILLINOIS
Chicago—Peoples Gas Bldg., Michigan Blvd.
Decatur—133-147 W. Williams St.
East St. Louis—600 Walnut Ave.
Peoria—Halligan Transfer Company, 721-31 S. Washington St.
Marion—315 S. Granite St., Box 747.
Monmouth—601 S. First St.
Quincy—222 S. Eighth St.
Streator—702 East Elm St.
INDIANA
Evansville—1601 Illinois St.
Indianapolis—110-112 S. Alabama St.
Terre Haute—921 Wabash Ave.
IOWA
Des Moines—117-119 Fifth St.
Dubuque—8th and Washington Sts.
Ottumwa—207-9-11 S. Washington St.
Sioux City—925 Fourth St., P. O. Box 398.
KANSAS
Pittsburg—109 W. Third St.
Salina—103 S. Fifth St.
Wichita—721 Beacon Building.
KENTUCKY
Louisville—126 E. Main St.
LOUISIANA
New Orleans—715-717 Perdido St.
MAINE
Portland—202 Commercial St.
MARYLAND
Baltimore—19 E. Lombard St.
Cumberland—1 N. Liberty St.
Salisbury—Opp. Fulton Station.
MASSACHUSETTS
Boston—(See Cambridge "A.")
Cambridge "A"—Waverly St. and Putnam Ave.
Springfield—Napier St.
MICHIGAN
Detroit—Jefferson Ave. and Orleans St.
Grand Rapids—135 Ottawa Ave., N. Y.
Hancock—First National Bank Bldg.
Iron Mountain—215 E. A St.
Jackson—172 South Water St.
Saginaw—1902 N. Michigan Ave.
Sault Ste. Marie.
MINNESOTA
Minneapolis—334 N. First St.
Virginia—413 Chestnut St.
MISSISSIPPI
Vicksburg—1312 Washington St.
MISSOURI
Kansas City—1316-1318 W. Eighth St.
St. Joseph—920 S. Sixth St., Sta. "A."
St. Louis—(See East St. Louis, Ill.)
NEBRASKA
Omaha—1007-9-11 Jones St., Union Sta. P. O.
NEW HAMPSHIRE
Concord—77 South Main St.
NEW JERSEY
Camden—Delaware Ave. and Cooper St.
Jersey City—554-56 Henderson St.
NEW YORK
Albany—108 Third Ave.
Binghamton—21 Jarvis St.
Geneva—Exchange St. and Railroad Pl.
Jamaica—11 New York Ave.
Kingston—O'Neil St., near Broadway.
New York City—42nd St. Building.
Niagara Falls.
Poughkeepsie—Smith St. and N. Y., N. H. & H. R. R. Tracks.
Roscoe.
Utica—127 Hotel St.
Watertown—438 Court St.
Whitehall—57 Canal St.
NORTH CAROLINA
Wilmington—105 North Water St.
NORTH DAKOTA
Fargo—17-19 Broadway.
OHIO
Cincinnati—63-65 Plum St.
Cleveland—601 The Citizens' Building.
Columbus—310 Dublin Ave.
Dayton—812-828 E. First St.
Lima—338 East High St.
Toledo—414 S. Erie St.
Zanesville—Main and Second Sts.
OKLAHOMA
Oklahoma City—27-29 E. Grand Ave.
OREGON
Portland—104 North 5th St.
PENNSYLVANIA
Beaver.
Du Bois—Weber Ave. and Franklin St.
Erie—1426 Chestnut St.
Harrisburg—627 Walnut St.
Johnstown—129 Jackson St.
Pittsburgh—32nd St. and Penn. R. R.
Pottsville—Railroad and Sanderson Sts.
Scranton—4 Cliff St.
Williamsport—Canal and Court Sts.
RHODE ISLAND
Providence—Allen's Ave., P. O. Box 419.
SOUTH CAROLINA
Charleston—153 Church St.
TENNESSEE
Chattanooga—700 E. Tenth St.
Knoxville—426 West Depot Ave.
Memphis—671 South Main St.
Nashville—105-107-109 Broadway.
TEXAS
Dallas—802-810 Cadiz St.
El Paso—900 Overland St.
Houston—Baker and Cedar Sts., Box 745.
San Antonio—Cor. Leal and N. Salado Sts.
Waco—633 S. 7th St.
UTAH
Salt Lake City—118 W. Second South St.
VERMONT
Burlington—87 College St.
VIRGINIA
Lynchburg—1324 Commerce St.
Norfolk—Cor. First and Front Sts.
Richmond—18th and Cary Sts.
WEST VIRGINIA
Bluefield—195 Roanoke St.
Charleston—Broad St. and K. & M. R. R.
Fairmont—"A" Street.
Huntington—820 3rd Avenue.
WASHINGTON
Seattle—411 Globe Bldg., First Ave. and Madison St.
Spokane—646 Peyton Building.
WISCONSIN
La Crosse—Front and King Streets.
Madison—309 East Wilson St.
Milwaukee—120-134 Jefferson St.

We recommend our customers to **select** from the list, the **city** from which the quickest delivery and lowest freight rate can be obtained, **and address their orders to "Union Carbide Sales Company"** at the distributing point selected **accompanied by remittance.**

Please address request for information or special correspondence to either the Chicago or New York office.

The
BASTIAN-BLESSING COMPANY
125-131 W. Austin Ave.
CHICAGO, ILL.

Dependable Safety Valves
For Acetylene Generators

Specialists in
Regulators, Apparatus Parts, etc.
Let Us Figure on Your Next Order

REGO TRADE MARK

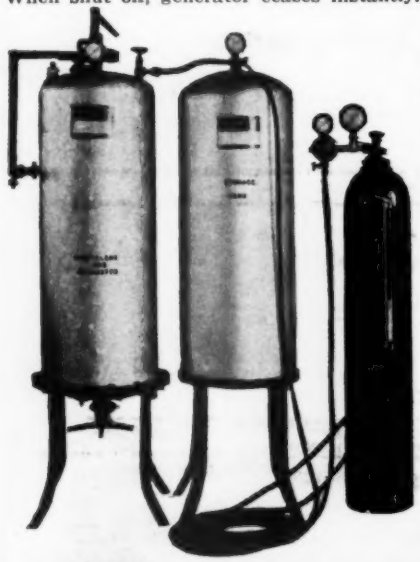
We Sell Manufacturers and Jobbers Only

THERMALENE — THE GAS OF GREATEST EFFICIENCY — THERMALENE

The Oxy-Thermalene Method
of Welding, Cutting, Brazing, Etc.

The only Acetylene Oil Gas generator in the world. Saves 25% on gas and oxygen. First class references. We also sell complete Oxy-Acetylene equipment for dissolved Acetylene for $42.00.

Thermalene gas in conjunction with Oxygen gas produces the ideal flame for welding and cutting. There is no loss of time due to shortage of gas. The generator works only when you work. When shut off, generator ceases instantly.



Thermaline will not produce faulty welds due to impure and moist gas. The generator may be mounted on a truck and made portable.

Thermaline Gas, being heavier and richer than Acetylene and other gases, has more body, producing a softer non-oxidizing flame, which assures a more uniform weld and a cleaner cut, without burning or making the metal brittle.

Write for full information, catalog and prices.

THE THERMALENE COMPANY
Chicago Heights, Ill.

THERMALENE — THE GAS OF GREATEST EFFICIENCY — THERMALENE

U. S. Gauge Company
New York

The WESTERN OXYGEN CO. has adopted the U. S. GAUGE as standard on their equipment. Its record in service, together with distinctive patented safety features commend it to the best trade.

New York, 67 Wall St.

Chicago, Clark Street Bridge.
San Francisco, 681 Market Street.
Detroit, 42 W. Larned Street.
Montreal, Board of Trade.

Works: Sellersville, Pa.

The "CHICAGO" Welder's Safety Goggles

For Gas Cutting or Welding
For Electric Welding Apparatus
For Arc Welding Apparatus

No. 380—Price $1.00

Ventilated Sides
Heavy Elastic
Leather Nosepiece

Ask your jobber for either of these. He can supply you.

Lenses of any color or shade desired.

No. 500—Price $1.50

Fibre Frame an Absolute Non-Conductor of Heat

Manufactured by CHICAGO EYE-SHIELD CO., 2300-06 Warren Ave., CHICAGO, ILL.

Oxweld Apparatus For Railroad Service

is to broken equipment what a new point is to your pencil. Its use gets the other 95% value out of your equipment that has broken long before its mechanical life should have gone.

Reclaim the profits discarded in your scrap pile with our Oxweld outfit. A broken tooth on a gear is easily built up and refinished and the gear goes back to work for its full life, and so on throughout the whole list.

On your wrecking trains this outfit will prove of untold value. Tangled steel wreckage is quickly cut up; service is quickly resumed. The cost is tremendously reduced. The profit is the difference between scrap value and replacement cost, less the small cost of repairs.

Oxweld Railroad Service Company

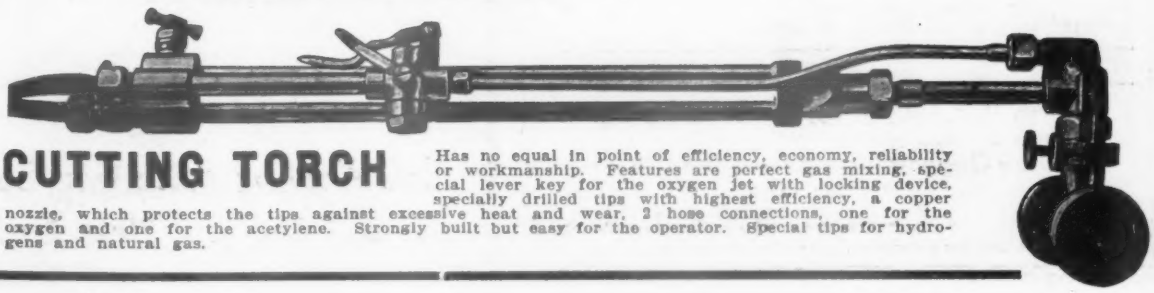
Railway Exchange Building
Chicago

30 Church Street
New York

GENERAL WELDING & EQUIPMENT CO.
G.W.&E.C.
107 MASSACHUSETTS AVE. BOSTON, MASS.

WELDING AND CUTTING EQUIPMENTS

Passed by Insurance Authorities, Used in Navy Yards and Other Important Concerns



CUTTING TORCH

Has no equal in point of efficiency, economy, reliability or workmanship. Features are perfect gas mixing, special lever key for the oxygen jet with locking device, specially drilled tips with highest efficiency, a copper nozzle, which protects the tips against excessive heat and wear, 2 hose connections, one for the oxygen and one for the acetylene. Strongly built but easy for the operator. Special tips for hydrogens and natural gas.

American Carbolite Sales Company

DISTRIBUTERS OF

CALCIUM CARBIDE

General Office:
DULUTH, MINN.

Trade Carbolite Mark

All Standard Sizes
Carried in Stock

Large and complete stocks of CARBOLITE, packed in drums and cases, carried on hand at the following distributing points:

Denver, Colorado
Victor, Colorado
Benton, Illinois
Chicago, Illinois
Decatur, Illinois
Peoria, Illinois
Springfield, Illinois
Evansville, Indiana
Indianapolis, Indiana
Terre Haute, Indiana
Albia, Iowa
Centerville, Iowa
Davenport, Iowa
Des Moines, Iowa
Knoxville, Iowa
Ottumwa, Iowa
Sioux City, Iowa
Atchison, Kansas
Pittsburg, Kansas
Bay City, Michigan
Grand Rapids, Michigan
Albert Lea, Minnesota
Duluth, Minnesota
Minneapolis, Minnesota.
Joplin, Missouri
Kansas City, Missouri
St. Joseph, Missouri
St. Louis, Missouri
Butte, Montana
Omaha, Nebraska
Fargo, North Dakota
Canal Fulton, Ohio
Cleveland, Ohio
Columbus, Ohio
Salem, Ohio
Portland, Oregon
Harrisburg, Pennsylvania
Wyoming, Pennsylvania
Salt Lake City, Utah
Seattle, Washington
Spokane, Washington
Madison, Wisconsin
Milwaukee, Wisconsin

Please address request for information or prices to Duluth, Minn.

WELDERS' GOGGLE No. 3

White non-rusting metal, folding screens, all metal parts covered to prevent the frame from getting heated and burning the skin. Fastened on by an elastic headband.

No. 3. Mounted with first quality gray green glass.....$1.50 each
Mounted with the new American Noviweld glass.....$2.00 each
Quantity prices upon application.

This goggle is a great improvement over similar goggles on the market, the screens and frame are all made in one piece making it easy to insert new glasses. The frame is of heavy construction and the temples are fastened to the end piece with screws.

The above goggles furnished with light smoked, blue, amber or clear white glasses

WILLIAM C. ADAMS

Manufacturer, Importer and Wholesale Dealer in

Welding Goggles and Protection Glasses

332 BOYLSTON STREET

BOSTON - - - MASS., U. S. A.

Write for Catalogue. Samples Submitted

Welding Grate Bars in the Manufacture of Smelter Grates

A large stock of **torches, regulators, gauges, reducing-valves, copper wire bound high pressure hose and plain black rubber gas hose,** and all extra accessories and supplies for this line of work, is in our shops, New York City, at your demand.

The K-G Apparatus is accepted by those who know as the best money can buy. It is built to stand up.

This is not merely a statement of our opinion, but is proven by their universal adoption and long continued use.

K-G Welding & Cutting Co., Inc.

Phone 6358 Greeley
556 West 34th St. **New York City**

Universal

UNIVERSAL OXYGEN COMPANY
SHEBOYGAN, WISCONSIN, U.S.A.

PURE OXYGEN and HYDROGEN GASES
WELDING and CUTTING EQUIPMENT
Milwaukee Branch: 315 Fourth Street

Let Us Show You Savings With

I.O.C. SYSTEM OXYGEN and HYDROGEN GENERATORS

If you are buying gas in cylinders—or if your generating plant is not strictly up-to-date—there is every probability that the installation of an I.O.C. Generating Plant would work economies that would soon pay for its cost, leaving later savings clear profits. Consult us—lay your costs before us—tell us your conditions. We will gladly advise you, free of charge. And, the possible savings having been demonstrated, decision is up to you.

Let us send you our new Catalog No. 3, describing the new I.O.C. Bipolar Generators

International Oxygen Company
115 Broadway, New York

Welding Plants for All Purposes

12 Sizes—Ranging in price from
$25.00 to $250.00

Write for catalog and our special 30 day offer.

A "BERMO" Plant means more profit for you.

Shipment made same day order received.
Liberal terms on plants if desired.

Address Department C.

Bermo Welding Apparatus Co.
Omaha, Nebraska, U. S. A.

How To Turn Experience Into Money

We are learning something every day about the art of welding. Old methods are being discarded and new methods employed. The Welding Engineer is anxious to hear from men with ideas—in fact, we pay for ideas. Put your experiences on paper—make rough pencil sketches of your ideas. We will put your ideas in readable form and pay you well.

Write Me Today

THE WELDING ENGINEER, L. B. Mackenzie, Editor
608 South Dearborn Street, CHICAGO

Industrial Preparedness

Industrial preparedness is a subject now engaging the attention of far-sighted business men. When the war ends, this country will be confronted by many problems of adjustment. Right now is the time to study your manufacturing methods and the methods used in making repairs in your plant. Perhaps by the aid of oxy-acetylene welding apparatus you could decrease expense and speed up the factory. Talk it over with us. We are experienced welders, and if it can be done, we can show you how. Write us today.

"Willis" Pressure Generators

Made in sizes of 50, 100, 200 and 300 pounds carbide capacity per charge.

The generator of 50 pounds capacity is standard for repair shops and light manufacturers, while the larger sizes provide an ample supply of gas for more extensive use.

They have independent power for feeding lump carbide and automatically starts and stops, depending on pressure. Needs no attention after being filled. This is the best generator on the market.

"Willis" Torches

The Willis torch is of the medium pressure type and is known as the constant neutral torch. The mixture of the gases is obtained in the head, and interchangeable tips of different capacity are provided to regulate size of flame.

Heads having different angles are furnished and are also interchangeable. For ordinary bench work a torch having a head at about a 90 degree angle is most desired, while for boiler welding such as side, flue, or crown sheet work, a much greater angle than 90 degrees is preferable. The heads rotate on the torch proper and are easily and quickly turned to any angle in the arc. For overhead work and certain other classes, this is of great assistance. We guarantee our torch to procure as low a ratio of oxygen to acetylene as it is possible to obtain and maintain a neutral flame.

Write today for booklets

The Henderson-Willis Welding and Cutting Co.

General Office and Factory: St. Louis, Mo., U. S. A.

Swift Oxygen

For Welding and Cutting

Unsurpassed for Quality

Pure Oxygen Electrolytically Made under the direct supervision of our Chemical Laboratory. It is carefully controlled by chemical analysis, thus insuring the highest obtainable purity.

We carry a large stock on hand so can fill orders immediately.

Swift & Company

Oxygen Department **Union Stock Yards, Chicago, Ill.**

Canada Carbide Sales Company

30 Church Street
NEW YORK CITY

WORKS
Shawinigan Falls, Que.
Merritton, Ont.

Sales Agents of

CANADIAN CARBIDE

"More gas per pound"

SIZE PKGS.
100 lb. and 1,000 lb. 25-lb. drums; 10 lb., 5 lb., 2 lb., 1 lb. tins

DISTRIBUTING STATIONS

ALABAMA
Bessemer—2014-2024 Second Ave.
CALIFORNIA
Los Angeles—52nd St. and Santa Fe Ave.
San Francisco—731 Market St.
ILLINOIS
Chicago—105 W. Monroe St.
LOUISIANA
New Orleans—Camp and Common Sts.
MARYLAND
Baltimore—17 So. Hanover St.
MASSACHUSETTS
Boston—47 Oliver St.
Springfield—50 Taylor St.
MICHIGAN
Detroit—343 Belleview Ave.
MINNESOTA
Duluth—Third Ave. E. and Michigan St.
MISSOURI
Joplin—Opposite Post Office.
NEW JERSEY
Newark—See New York.
Paterson—61-63 Washington St.
NEW YORK
Buffalo—Seneca and Hamburg Sts.
Malone—32-34 W. Main St.
Middletown—28 W. Main St.
New York—30 Church St.
Troy—6 and 8 Grand St.
Trumansburg—55 Main St.
Watertown—112 Franklin St.

Manuf'd in all standard sizes

DISTRIBUTING STATIONS

OHIO
Toledo—Address Detroit.
Canal Fulton, 25 S. Canal St.
PENNSYLVANIA
Altoona—2101 Beale Ave.
Barnesboro—Ann St. and Maple Ave.
Johnstown—134 Clinton St.
Montrose.
Pittsburgh—2223 Farmers Bank Bldg.
Pottsville—Centre and Market Sts.
Punxsutawney.
Scranton—339 Penn Ave.
RHODE ISLAND
Providence—543 Charles St.
TENNESSEE
Knoxville—1761 Asylum Ave.
TEXAS
Fort Worth—23rd and Jones Sts.
Houston—Address Fort Worth.
UTAH
Salt Lake City—121 W. 2nd South St.
VERMONT
Burlington—Park Ave.
VIRGINIA
Richmond—1319 E. Main St.
WEST VIRGINIA
Charleston—821 Virginia St.
Huntington—1032 Third Ave.

For special information address correspondence to New York City.

Regulators

you can depend upon. Guaranteed to be absolutely accurate and to remain so.

The Patented Features of this regulator means that adjustment or replacement of the valve seat can be made by anyone using only a wrench and screw driver.

Write for prices

Complete welding equipment

F. C. KUHNLE & CO.

Manufacturers of
THE GRANT REGULATOR
(Patented 1915)
4315-17-19 EVANS AVENUE
PHONE KENWOOD 4123 **CHICAGO**

No. 8-G Blowpipe
For Natural Gas, $4.25

The Two Most Essential Points in Welding

ARE

FIRST: The use of a proper sized oxy-acetylene flame.

SECOND: The saving of gas by preheating your work for the oxy-acetylene flame.

The first is under your control in the use of the oxy-acetylene apparatus you have selected.

The second we can aid you in by supplying the proper blowpipes for preheating purposes.

Over forty years' experience in the manufacture of this article has enabled us to produce a series of blowpipes that will give you the maximum amount of heat with the minimum consumption of gas.

It is not practical or economical to use a blowpipe larger than our No. 8-G—for natural gas, or No. 8-F—for coal gas. If you have a piece of work requiring more heat than a single blowpipe of this size will give you, use two or more blowpipes of this size.

Our catalog "BX"—free for the asking—contains full description of all our blowpipes. WHAT'S YOUR ADDRESS?

BUFFALO DENTAL MANUFACTURING CO.

BUFFALO, N. Y., U. S. A.

Blowpipes for Coal Gas, Natural Gas, Gasoline Gas and Acetylene Gas and Air Blast

UNITED STATES WELDING COMPANY

FORMERLY CAMPBELL & RICKEL

MINNEAPOLIS, MINN.

U.S.

OXY-ACETYLENE
WELDING
CUTTING

CARBON BURNING
APPARATUS

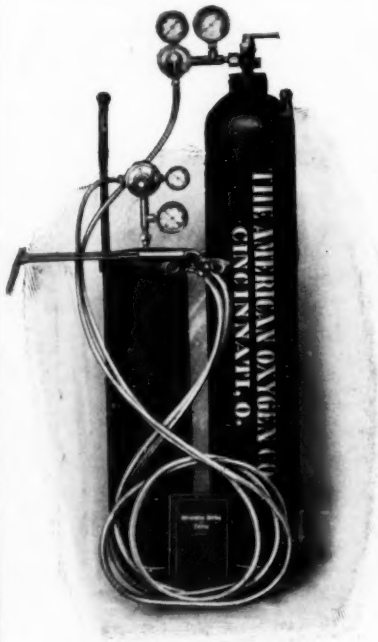
PARTS AND
SUPPLIES

234-236 HENNEPIN AVENUE
MINNEAPOLIS, MINNESOTA

Pure Oxygen

Pure oxygen is essential to good work. If your oxygen supply is not up to the standard set by "American" and "Watergas" oxygen then the best welding and cutting apparatus to be had will not do your work properly.

We are glad to recommend "Vulcan" welding and cutting apparatus to our customers. No better tools are made and when used in connection with "American" and "Watergas" oxygen, with high grade acetylene, we know our customer will get results.



Write our nearest office for prices. Prompt shipments made at all times.

American Oxygen Co.
Cincinnati

Indiana Oxygen Co.
Indianapolis

HOOVER WELDING AND CUTTING APPARATUS

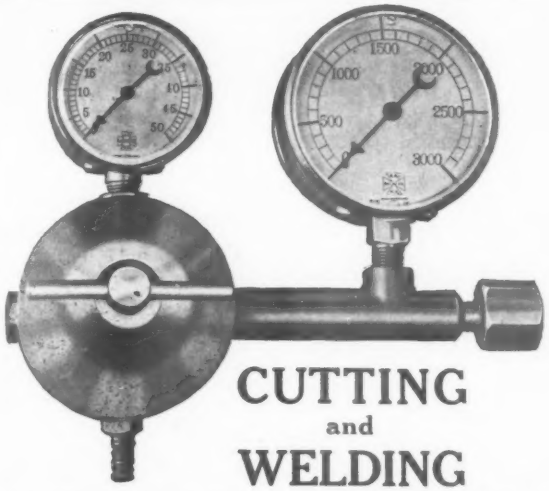
This new welding and cutting torch represents the very last word in efficiency. The Hoover torch can be adjusted to any class of work, large or small. With it the operator may meet and overcome difficulties usually requiring at least five different torches.

REASONS WHY

1. The Hoover torch is adjustable to every job.
2. It is possible to manipulate the valves with the torch hand, leaving the other hand free. This is a big advantage.
3. "Flash Backs" are reduced to the minimum in the Hoover torch. The mixing chamber is remote from the heat.
5. The cutting head has no tips, being cast en bloc. There are no joints to work loose and leak.
6. The Hoover torch is well balanced and is light.
7. The materials and workmanship employed in manufacture are of the very best.

Before you buy you owe it to yourself to get our prices and circular. Shipment on the day you order.

OXY-ACETYLENE PRODUCTS CO.
810 Diversey Parkway, CHICAGO



CUTTING
and
WELDING
REGULATORS

For ACCURACY—EFFICIENCY
and ON ALL DELICATE WORK

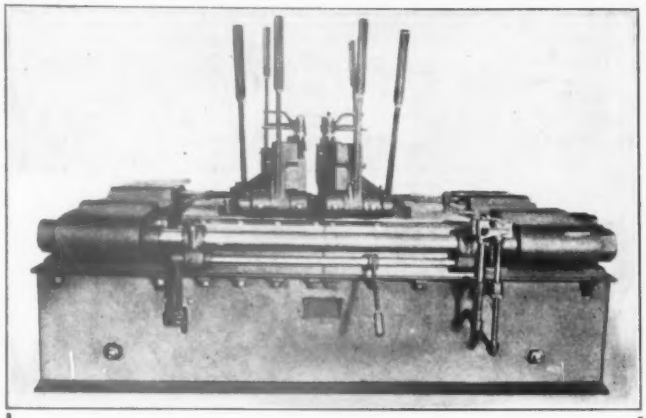
Welding Apparatus, High Pressure Specialties

FEDERAL BRASS WORKS

Largest and Oldest Regulator Manufacturers in the U. S.

31st St. and Kedzie Ave. CHICAGO

MFGRS. OF THE ONLY NON-BACK-FIRING WELDING TORCH



Butt Welders a specialty. 200 K. W. Welder, hydraulic pressure, clamps for stock up to 1 inch thick and 18 inches wide auto-truck rims, etc. 102 x 86 x 66 inches high, 12,700 lbs.

The "Thomson" Electric Welders

They are efficient and do not require an expert to operate. Operate the levers and the machine does the rest. No noise or confusion—no danger. In your plant you may have use for a "Thomson" Electric Welder. Why not prepare to reduce your manufacturing costs by studying the possibilities right now? Describe the shape, tell us the size of the smallest and largest piece, the maximum number of welds required per day, the cost of current per kw. hour; we will then tell you what it will cost you to electric-weld. If you haven't an alternating current, your local Lighting and Power Company has.

Weld Your High-Speed Steels

⁘

We Job Weld Also

⁘

Thomson Electric Welding Co.

Lynn, Mass.

The Pioneer Manufacturers

Hints To
WELDERS

Can you write intelligently about the welding work you do, or which is done under your supervision? That is to say, when you finish an interesting piece of work, can you set down on paper the manner in which you went about the job, how you prepared the work, how you preheated and how the job was done? Have you learned in the hard school of experience some little stunt which every welder ought to know? If you can answer yes to the above questions you are the man I am looking for. I'll pay you a fair price for that bit of experience and I'll print it in The Welding Engineer "Hints to Welders" where more than 4,000 of your fellows will see it. Write it down any old way—I'll polish it up. Make a rough pencil sketch and our draughtsman will fix it up fine. Line drawings are more practical than photographs. Do it today—the men on the firing line are waiting.

L. B. MACKENZIE, Editor

The Welding Engineer

608 S. Dearborn St., : Chicago

Oxy-Acetylene Welding and Cutting

Welding frame of automobile top by oxy-acetylene process. Done quickly, and secures neat finish and quality of joint impossible by any other process.

Has a Distinct Field—

In Addition Is a Valuable Supplementary Process

No matter what other welding methods you may now be using, the Prest-O-Lite Process offers additional savings, through the wide range of additional work made possible. In many instances, the added quality, economy of labor and materials so easily effected by the Prest-O-Lite Process are entirely outside the range of other welding processes. The perfect portability of the outfit makes it decidedly superior to any stationary plant on a wide variety of jobs, outside and inside the shop.

In ordinary repair work alone the process saves its initial cost many times over in a very short time.

You may be using other welding processes profitably, but in addition the Prest-O-Lite Process will pay back its small cost quickly. The utmost economy and efficiency of oxy-acetylene welding are afforded by the

Prest-O-Lite PROCESS

Employs both gases (acetylene and oxygen) in portable cylinders. Prest-O-Lite Dissolved Acetylene (ready-made carbide gas) is backed by Prest-O-Lite Service which provides dry, purified gas, insuring better welds, quicker work, and lower cost, and also avoids the large initial outlay and heavy depreciation incurred in making crude acetylene in a carbide generator.

Necessary equipment is not expensive. We furnish high-grade welding apparatus for $60 (Canada, $75); acetylene service at additional cost. Adaptable for oxy-acetylene cutting by the addition of special cutting blow pipe. Thorough instructions are furnished free to every user of Prest-O-Lite Dissolved Acetylene—any average workman who understands metals can learn the process quickly and easily.

The advice and assistance of our welding experts are at the disposal of all Prest-O-Lite Process users at all times. Send for our illustrated book on welding entitled, "Turning Waste into Profit." Sent free if you are interested. Use the coupon.

W. E.

THE PREST-O-LITE COMPANY, INC.

Gentlemen:
I am interested in cutting costs and increasing quality in metal manufacturing and repairing.
Send me "TURNING WASTE INTO PROFIT."

Name.....

Address.....

With (Firm) .....

Have Used Welding: Yes..... No.....

The Prest-O-Lite Company, Inc.

The World's Largest Makers of Dissolved Acetylene

Main Office and Factory
851 Speedway, Indianapolis, Ind.

Canadian Office and Fatory
Merritton, Ontario

53 Branches and Charging Plants

The Welding Engineer

Published on the First Thursday of Each Month by

THE WELDING ENGINEER PUBLISHING CO.,
608 S. Dearborn St., Chicago, Ill.
Telephone Wabash 7134.

L. B. Mackenzie.....President and Editor

Subscription payable in advance and postage free.
United States, Canada and Mexico.....$2.00 a year
Foreign Countries ..... 2.50 a year
Single copy, domestic .....20 cents
Single copy, foreign .....25 cents

Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

The Welding Engineer is a member of the Audit Bureau of Circulations.

We guarantee that of this issue more than 4,000 copies were printed, excluding copies spoiled in press room and bindery. At the time of mailing the known distribution was (actual count always exceeds press order):

Copies to paid subscribers	1,727
Copies to advertisers	50
Sopies to prospective advertisers	142
Copies to other trade papers, correspondents, etc	16
Copies mailed as samples to prospective subscribers	1,755
Copies retained at office of publication to fill new subscription orders, etc	300
Copies for office use	10
TOTAL	4,000

VOLUME I. JUNE, 1916. NUMBER 6

Industrial Preparedness.

A GREAT deal is being said these days about industrial preparedness. Industrial preparedness means nothing more or less than efficiency in one's business. Make the goods a little better and a little cheaper, and market them more scientifically. Every manufacturer owes it to himself to keep in close touch with conditions in his field. The methods of today are consigned to the scrap heap tomorrow. In practically every big establishment methods are being followed and work is being done after a fashion which is obsolete. We believe, to carry out the Industrial Preparedness theory thoroughly, it would pay every manufacturer to call in an authority on the subject of welding. Let him look over your shop methods with a view to suggesting improved methods.

Efficiency on Railroads.

RAILROAD organizations are necessarily so big and cumbersome that quite frequently it will be found that while one department is thoroughly conversant with an improved method the department next door knows little or nothing about the subject. We believe that in some cases this may be said to be true of welding. In the Mechanical Departments the subject of welding has received considerable attention, but in other departments little or no progress has been made.

The Signal Departments and the Water Departments, for instance, have done but little to thoroughly try out the efficiency of welding methods. Our readers have no doubt noticed the great number of pipe connections at mechanical interlocking plants. Inch and one-quarter pipe is used to connect the switch, derail or signal, as the case may be, with the lever in the tower house. The railroads purchase this pipe in lengths of about 14 to 16 feet. One end is threaded, plugged with a steel plug, and the other end is fitted with a coupling. This pipe is carried on what are termed "pipe carriers" and when a coupled joint occurs at a pipe carrier it is necessary to cut off a short length, say a couple of feet, so that the coupling will come between pipe carriers. This necessitates rethreading the pipe.

The Editor of *The Welding Engineer* has talked with a few signal men on this subject and so far as he can determine there is no reason why a welded joint would not be much better from every standpoint. In fact an experienced welder who has just investigated the subject informs us that signal pipe can be welded successfully at about half the present cost of coupling.

The inside finish of the weld is not important and the necessary bevel is practically accomplished when the pipe is cut. Furthermore, at large interlocking plants, it is usually the practice to employ a repairman, who is a blacksmith. This man makes many repairs which could be made quicker and better with welding apparatus. We have frequently heard of interlocking plants being thrown out of service because of a broken casting, for instance, a job which would have been a simple matter for an oxy-acetylene welder.

In our March issue we published test reports of oxy-acetylene welded pipe connections, as made by the Director of the Fowler Shops, University of Kansas. This report showed conclusively the superiority of welded pipe joints over coupled joints.

How to Help the Cause of Welding.

MOST of our readers have no doubt been attracted to the "Questions and Answers" and "Hints to Welders" departments, published in every issue. This month we are consolidating the two departments, for the very good reason that the matter appearing in each department is so similar that it would seem to belong to the same department. For the information of our readers we might say that we compensate those gentlemen who contribute to the "Hints" department. Not a large sum, 'tis true, but measured by the prevailing price of a welder's time, a very fair price. Those of you who are engaged in the welding industry, however, should be glad to pass on your experiences to your brother welders, regardless of the question of remuneration. Don't think that because you spent years in gaining experience you can afford to let the other fellow find out for himself. If you read every issue of *The Welding Engineer* and fail to learn something we want to know you. So help to build up the welding industry. Help the other fellow cut down the percentage of his mistakes. It will further the cause, strengthen the general public's faith in welding, and incidentally reflect to your advantage.

Good Welders Are Needed.

IT is evident that there is a scarcity of competent welders in this country. That is to say, men who are competent are situated satisfactorily and are disinclined to make a change. On the other hand, those welders who seem inclined to look for something better seem to prefer the position of salesman or demonstrator, for which there is little or no demand. It would seem that welding is a trade, or occupation, which offers bright prospects to young men of a mechanical turn of mind. The welder will always enjoy plenty of opportunities to demonstrtae his mechanical ability. The man who is an all-around machinist, however, enjoys an advantage, and we know of no better opportunity for the young machinist than to make a study of and specialize on welding.

Electric Arc Process of Welding

As a Commercial Process Electric Arc Welding Is Growing in Favor—A Brief Digest of the Process

By J. H. Bryan*

Welding is the art of joining metals together into intimate and permanent union. There are two processes, welding by pressure or hammering, and autogenous welding. Up to half a century ago welding by pressure or hammering was the only process known, the common form of which is the blacksmith's weld. Recently it has been possible to employ electricity for this method of welding, the process being called incandescent welding, better known as butt and spot welding. With this process the two parts to be joined together are placed in contact with each other and by means of suitable equipment a heavy current is caused to pass from one piece to the other. This heats the metals to the fusing point. The two parts are then pressed together and the weld is completed. A more recent modification of incandescent welding is that known as electro-precussive welding, by which it is possible to weld metals having widely different melting points, or metals not commonly susceptible of being welded.

The second process of welding, called autogenous welding, may be defined as being the fusing together of two metals without pressure by causing them to melt and then unite as they cool. It differs from the older method in that successful results may be produced without hammering or pressure. Welding by the use of the electric arc or by the various processes employing gases such as the oxy-acetylene or oxy-hydrogen method comes under the head of autogenous welding.

Electric Arc Welding

Electric arc welding as a commercial process may be divided into two general classes: the carbon electrode process in which the arc is drawn between the metals to be welded and a carbon electrode, and the metal electrode process in which the arc is drawn between the metal to be welded and a metal electrode. Through the medium of the arc, which is the hottest flame known, having a temperature between 3,500 and 4,000 degrees Centigrade (6,300 and 7,200 degrees Fahrenheit), the metal may be either entirely melted away, molded into a different shape, or fused to another piece of metal as desired.

Electric arc welding requires: a suitable source of direct current supply; an adequate control system; a means of holding the electrode so that it can be properly manipulated by the operator; protective covering for operator; suitable filling material, and such miscellaneous material as flux, or carbon blocks for making molds, etc.

Direct Current Supply

So far it has been possible to do satisfactory arc welding on direct current circuits only. The principal trouble with alternating current for arc welding is that the arc is very unsteady, noisy, and hard to handle. In addition, the arc has a tendency to go out as the current passes through zero.

Arc welding is inherently a low voltage application of power and although welding can be done from direct current circuits of 110, 220 or 550 volts, this practice is extremely wasteful of power and should be permitted only in emergencies or when the cost of power is so low it can be neglected. Best results are produced on 75 volt circuits. This usually necessitates the use of a motor-generator set. If, however, electric power is not available a generator driven by a steam or gasoline engine may be employed as a source of supply; the most economical method is, of course, to use a motor-generator set, the motor being constructed with characteristics suitable for operation on the existing circuit and used to drive a low voltage generator. The generator may be either shunt or compound wound. The shunt wound machine is satisfactory only where one arc is operated. The compound wound machine is preferable if several arcs are to be supplied from the same unit. When compound wound, the generator should be provided with commutating poles on account of the heavy overloads incidental to welding work. The amount of compounding depends upon local conditions. In some cases flat compounding may be best, while in others it may be necessary to over-compound from 3 to 4 per cent at full load. The latter amount is especially desirable when an induction motor is the driving unit, on account of the decrease in speed when the load comes on the motor. The capacity of the motor-generator set is determined largely by the class of welding to be done and the number of operators working simultaneously. From the standpoint of heating, the temperature rating of the machine is not important as welding is essentially an intermittent service. If, however, the arc is used for cutting work, such as risers on steel castings, then the service may approach continuous operation and due allowance must be made for such conditions.

Control Apparatus

As different welds require different strengths of current a suitable means for regulating the current supply must be provided. This is usually done by inserting resistance in the welding circuit, connecting it in series with the arc. Without this resistance a condition of practical short circuit would occur at the instant the electrode was touched to the work when striking the arc, and, even after the arc is drawn and normal operation begun, the series resistance is necessary for the purpose of steadying the arc, much as is the case with the ordinary arc lamp. Switchboard and control apparatus for arc welding has passed through a period of development during which a number of schemes have been used to a greater or less degree of success. Now, however, due to improvements in the generating equipment, particularly the use of commutating pole machines, a system of control has been devised which is extremely simple.

Electrode Holders

A suitable electrode holder must be provided for both carbon electrode and metal electrode welding, as on account of the heat of the arc it is necessary to fasten the electrode itself in a holder. There are two distinct types of electrode holders, one for carbon, the other for metal electrode welding. The carbon holder consists of an aluminum rod, one end of which is provided with suitable connections to the cable supply current. A tube is welded on the other end of the rod, serving as a receptacle for the jaws or clamps holding the electrode proper. The end adjacent to the cable is provided with an insulating and heat resisting handle and a shield to protect the operator not only from an electric shock, but his hand from the heat

*Westinghouse Electric & Mfg. Co.

of the arc. The electrode itself is a hard, solid carbon or graphite rod from six to eight inches long and ½ to 1½ inches in diameter. It is light enough to be easily handled, is strong mechanically, and has ample carrying capacity for currents up to 600 amperes. Where currents of 800 amperes are required, a larger holder, similar in construction to the 600 ampere holder, is necessary. The metal electrode holder differs from that for the carbon electrode in that it is lighter and more compact. The disc shield is omitted, since the metallic arc is not as powerful as the carbon arc. The gloves of the operator furnish ample protection. The electrode wire is clamped in the holder by a cam device so arranged that it will clamp different sizes of electrodes without adjustment.

Protection to the Operator

Protective equipment is necessary for the operator on account of the fact that the exposure to the rays of the arc causes an irritation and subsequent peeling of the skin if the exposure has been sufficiently long, say several minutes. The irritation is very similar to sunburn and is uncomfortable, but no serious consequences ensue, and at the end of a few days all traces of the burn disappear. The clothing has been found to be ample for the protection of the body. For the eyes and face of the operator a hood or shield is provided, both of these being arranged with windows of thick colored glass through which the welding is observed. Experience has shown that, where carbon electrode work is being done, especially when the work is being carried on in an enclosure, the hood is preferable to the shield or mask, as it gives entire protection from reflected light, which is not the case with either of the latter devices. The hands and wrists of the operator should be shielded by gauntleted gloves, which are preferably of leather, although canvas gloves have been found to be satisfactory. The window of the hood or shield should be provided with several pieces of glass in layers, one or more or red and one or more of blue or green, the combination of these colors being much more satisfactory than any one of them used alone.

In addition to the protective covering for the operator himself, arrangements should be made for a suitable enclosure around the work and operator so that the intense brilliancy of the arc will not interfere with other workmen in the vicinity.

For short welds, especially when the metallic electrode process is employed, a hand shield may be used. This shield can be constructed of sheet or aluminum, and is provided with glass windows of the same construction as in the hood. The hood or mask is for general use, and must be used when the operator requires the use of both hands, as in carbon electrode work when filling-in material is to be supplied to the weld.

Filling-in Material and Fluxes

When the carbon electrode is used, the filling material is usually of the same metal as that being worked upon and may be used in any convenient form. For instance, when welding steel and iron, the filling material may be in the form of rods, clippings from boiler plate, steel chippings, etc. For cast and malleable iron, soft iron rods, punched iron scrap or special cast-iron filler may be used. These filling materials are fed into the welds and fused into place much as solder is applied with a blow-torch.

When metal electrodes are used for welding iron and steel they should be of best quality of soft iron or steel wire and may range in diameter from $\frac{1}{16}$ inch to ¼ inch. The length most generally used is about 12 inches. Copper, bronzes and brasses with a low percentage of zinc may also be welded by this process, in which case the electrodes should be of the same material as that being welded. Where the zinc content of brasses is high, it volatilizes to such an extent as to make the work porous and brittle. Whether or not a flux is used depends altogether on the individual operator, as usually material difference can be noted in the resulting weld. In welding cast iron, however, experience indicates that a flux is desirable. There are several formulas for the compounding of suitable fluxes. One which has been found to work satisfactorily consists of a mixture of from 15 to 25 per cent of red oxide of iron and 85 to 75 per cent of borax. The theory of its use is that any carbon which may have been introduced into the weld from the carbon electrode will unite with the oxygen in the flux and form carbon dioxide, leaving pure iron as the residue. If, however, the gas should not be entirely eliminated it will cause sponginess in the metal. To prevent this the weld should be well hammered. The borax tends simply to prevent oxidation by excluding the air.

Art of Welding

Welding by the electric process is an art and like all arts is not subject to definite rules. There are, however, certain fundamental principles that must be observed. Having observed them, the degrees of success attained will depend almost entirely upon the skill and intelligence of the operator. Some pick up the art easily and in a short time. Others experience difficulty and never produce consistently good work.

The process of arc welding may be divided into three distinct operations: Preparation of the work; striking the arc, and manipulation of electrode, filling material and the article being welded.

Carbon Electrode Process

In making a weld by the carbon electrode process, the work is connected to the position terminal of the machine. The work, if small, may be laid upon a metallic table which forms the positive terminal. The resistance of the circuit having been adjusted to what is considered the proper value for the work in hand and the circuit breaker and main switch being closed, the operator assumes his position in front of the piece to be welded, taking the electrode holder in one hand and having flux (if same is used) and filling material within easy reach. He finally closes the window of the hood, touches the carbon electrode to the metal to be welded and instantly withdraws it to a distance of 2 inches or more, thus striking the arc. Experience has indicated that with a long arc there is less opportunity for carbon particles to enter the metal and in this way produce a hard weld; the heating effect is also more regular and more evenly distributed. For these reasons the arc should be as long as possible, about 3 inches to 4 inches being the usual length. If the arc is found to be too fierce or to go out due to insufficient current, the resistance in the circuit may be increased or decreased accordingly.

After the arc is drawn it is allowed to play upon the work, being given a rotary motion by hand. The object of this motion is to heat a comparatively large area of the surface about the weld so that the consequent cooling will take place more slowly and there will be less danger of cracking the work or of making a hard weld. When the metal flows, the flux (if used) and the filling material should be added a little at a time, the arc, of course, being continued until the metal is thoroughly melted and the weld made. As soon as the metal commences to cool it should be hammered thoroughly in order to prevent sponginess and to give the metal a finer grain. All oxide and other impurities must be kept out of the weld. It is advisable, therefore, to make, if possible, one continuous application of the arc. When, however, more than a single application

is necessary, care should be taken to remove all the scale. This may readily be done in most cases by means of a stiff wire brush. Similarly the metal should be cleaned before commencing the weld. To accomplish this, chipping may be resorted to or the piece may be tilted, the arc applied and the impurities allowed to run off by gravity as fast as melted.

The current required for carbon electrode welding varies from a minimum of about 200 amperes to a maximum of around 700 amperes, or even more in very heavy work. In general, however, 300 or 400 amperes have been found to be sufficient for ordinary carbon electrode work.

As is indicated in the foregoing, carbon electrode welding is more or less of a puddling process. A considerable amount of heat is generated, and this is, in many cases, objectionable on account of the expansion of the work, in which strains may be set up on subsequent cooling and shrinking. In work where trouble of this nature is liable to be experienced, preheating may often be used to advantage. On small work this may be done by the use of the carbon electrode. The arc is drawn just as in welding, but it is moved about over the piece without being held in any one place long enough to cause fusion. With larger pieces, a temporary furnace may be made by laying fire brick together loosely to form an enclosure around the casting and over it. Heating may be done in any convenient manner either by the use of oil, gas or coal. When the work has reached a red heat, the cover is removed and the welding done without taking the piece from the furnace. After welding has been completed, the cover is replaced and the work allowed to cool slowly, either with or without a second application of heat.

The carbon electrode process is also well adapted for cutting of metals. In cutting, the arc is drawn just as in welding and is played along the line to be cut, provision being made for the melted metal to run off. This process of cutting is used to advantage in work such as cutting off risers and sink heads from castings in steel foundries, cutting up scrap and the like.

Metal Electrode Process

The metal electrode process, though a considerably later development than the carbon electrode method, has a field of application very distinct in many cases from the older process. A principal advantage of its use is in work where it is desirable to localize the heat to the greatest extent possible, thus minimizing strains due to expansion and subsequent contraction. An example of this is in the welding of sheet metal or of a broken bridge in a flue sheet. Another advantage of this process is that it enables welding to be done in a vertical plane or even from the underside of the piece to be repaired. This class of work is done daily in railroad shops in repairs to the side sheets and crown sheets of locomotive fire-boxes.

The method of using the metal electrode differs from that of the carbon electrode in that a much shorter arc, generally ⅛ inch to ¼ inch in length, is used, and also in that the electrode forms the filling material as it melts and flows into the fused portion of the work.

With the metal electrode much lower currents are used than in the carbon electrode process. The maximum value hardly ever exceeds 150 to 175 amperes. For a greater portion of the work a current of about 100 to 130 amperes is found satisfactory, although the amount of current required will vary with the size of the electrode and the class of work being done.

Application

The field for the application of electric arc welding is an extremely broad one. Practically every industry making use of iron and steel can utilize the arc welding process to good advantage. In large metal working shops both the metallic and carbon electrode processes are used not only for the repair of broken and defective steel castings, but also as a regular manufacturing process. In foundries and machine shops many applications for arc welding can be found. The principal application is the cutting off of risers, which can be done regardless of the area of cross section. Street railway systems have many applications for electric arc welding, both for trade repairs and for maintenance work on rolling equipment, repairing broken motor frames, worn trucks, brake rigging, and in fact all steel parts subject to wear.

Steel mills can use arc welding to advantage. The ends of wobblers and pinions which have become badly worn can be built up to their original size. Blast furnaces, which are an adjunct to steel mills, furnish a very interesting application.

The most useful field for arc welding, however, is in connection with steam railroad repair shops. Among the principal uses here are: for flue welding, fire-box repairs, frame repairs, and building up of worn parts. Other applications include the repairing of corroded mud rings, building up flat spots on driving wheels, welding spokes of driving wheels, welding cracks in fire-box sheets, welding broken bridges in flue sheets, etc.

There are a number of minor applications for arc welding, among which may be classed general repair work in large shops, work in steel plants, and cutting up of scrap. Industrial plants employing a large number of machines will oftentimes be able to reduce their maintenance expense very considerably by the use of arc welding equipment. Repairs to be taken care of in these shops consist of broken shafts, worn journals and keyways, broken gear teeth, worn rolls, etc.

An industry of comparatively recent origin is that of the repair of marine boilers. Practically every large harbor now contains one or more repair barges. These barges are equipped with an arc welding equipment and a compressor for furnishing air for sand blast and pneumatic tools; they are employed in the repair of the boiler equipment of vessels that may arrive in the harbor in need of such repairs. The barge is brought alongside the vessel while the latter lies at the dock; cables and air hose are carried through convenient port holes to the point where work is to be done, thus enabling the necessary repair work to be accomplished without any loss of time on the part of the steamer.

CUTTING TORCH SAVES LIFE

The following clipping from a Chicago newspaper tells its own story:

"Firemen used an acetylene torch to burn a hole in the side of a steel water tank on the roof of the twenty-three story Transportation building, to rescue John Pedraza, 15 Quincy street, a painter who was overcome by paint fumes while working on the interior of the tank.

"The new paint on the inside of the reservoir ignited, but was quickly extinguished.

"Pedraza, who had been unconscious, was revived and removed through the hole and taken to St. Luke's hospital."

This took place on the roof of the building which houses The Welding Engineer. We should have been on the job with a camera.

Manufacturers of musical instruments are taking up welding. In fact most of the larger manufacturers have been using apparatus for some time. One large manufacturer in the West has found it possible to substitute cheaper materials for German silver springs, valves, etc., by welding on a tip only of the more expensive material.

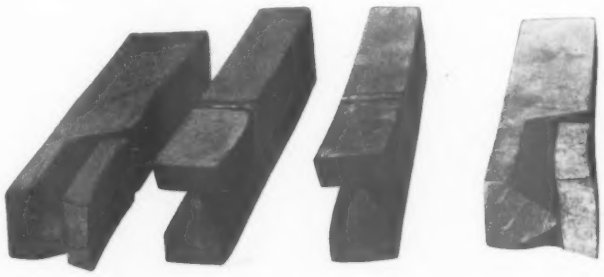
OXY-ACETYLENE WELDING WITH HIGH SPEED AND HARD STEELS

By B. Kopferschmidt

Before the development of the different kinds of steel, crucible steel, cast steel and tool steel were the only steels from which tools were made. These tools did their work well for certain kind of machine work, but with the development of our modern steels, its inadaptability has become eminent.

The first indication of improvement on carbon tool steel, in the line of ability to stand rigid wear, was the introduction of tungsten steel. Tungsten steel has several peculiarities that distinguish it from carbon steel. It is an extremely hard steel, and cannot be easily forged, and when heated and forged it resumes its hard condition after slow cooling. On the grinding wheel, tungsten steel shows a dull red spark, entirely different from the spark given off by carbon tool steel. Recently, methods have been found for annealing tungsten steel to a limited degree, so that its use is no longer limited by its hard and brittle nature. Another point of difference that calls for consideration is that of the present price. The best carbon tool steel costs about 35 cents per pound, while the tungsten steels are worth about $3.00 a pound.

Tungsten has paved the way for the introduction of the modern high speed steels which are designated by various names, such as air hardening, self hardening, high speed, etc.



Another cutting tool metal just out in the market is stelite.

On account of the high price of these improved grades, it has been found economical to use the steel in small sections, which can be carried in a mild steel holder, which usually provide means of clamping by a set screw. While these holders are very handy, still they cannot be made as rigid as a solid forged tool. In some shops the vibration caused by the screw is done away with by soldering or brazing small pieces of high speed steel onto mild steel shanks. For light work this method has proven satisfactory, but for the heavy work it is found inadequate, and oxy-acetylene welding takes its place.

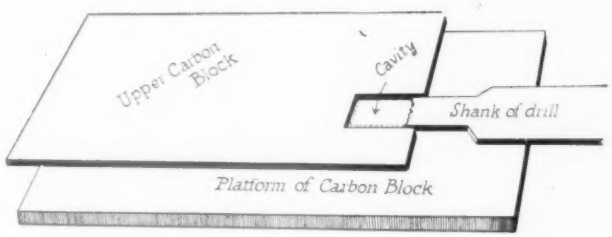
Typical examples are shown in figure 1, of four mild steel shanks, bevelled at the edges, and four pieces of high speed steel bevelled at one end, where it is coming in contact with the mild steel shank.

Method of Welding

Preheat the high speed steel in a smithy furnace to a dull cherry red, then build up ⅛ inch metal on the side that is to be welded to the shank, using a 5/32-inch or ¼-inch nickel steel welding rod and a cleaning powder used for cast iron. During the operation the tool shank should also be preheated at the edges where it is to be welded, to a cherry red. Then the high speed steel is set close to the shank as shown at the left in Fig. 1, and welded on both sides with the same welding rod, starting from the end. No cleaning powder is necessary on these welds. Then place the tool on the edgewise as No. 2 Fig. 1, and weld in the same manner as above.

If the welding operation is properly done the above method will prove as good as if it were a solid forged high speed tool.

To weld stelite metal to mild steel: mix some fire clay with a little borax and granulated glass and set the stelite plate on a 1-inch thick layer of fire clay, then build up about ⅛ inch metal on the side to be welded, using a ⅛-inch nickel steel welding rod and a cleaning powder used for cast iron mixed with two per cent of sal ammoniac powder. Then preheat the shank at the edges to be welded to a cherry red and set the stelite plated, attached with the fire clay if possible, close to the shank and weld the sides with the same welding rod. No cleaning powder is necessary for the latter operation. If the fire clay breaks during the setting of the



stelite to the shank a new layer about 1 inch thick may be replaced.

A good method of welding high carbon steels such as broken shanks of drills, taps or reamers is as follows:

In the case of a broken drill, place the drill in a vessel of water, leaving a distance of ¼ inch between the water level and the break. Then build up about ⅛ inch metal on top of the break, using a 5/32-inch pure Norway iron welding rod, with a cleaning powder used in cast iron. After the drill is well cooled, place the broken end on a carbon block. Another carbon block is taken, the thickness of which should be about the same as the size of the broken shank, and in in a hole should be cut out, the shape pof which should conform with the shape of the desired piece to be built on. The length of the cut should be somewhat larger than the desired piece. Place this block on the drill in such a manner that the cavity should be a prolongation of the broken end, as per Figure 2. Now build up metal in carbon cavity, joining the same with the metal built on previously in the water.

CAMPBELL & RICKEL CHANGE NAME

Announcement has been made that the old firm of Campbell & Rickel, Temple Court Bldg., Minneapolis, will in the future be known as the United States Welding Co. The new company recently incorporated in Minnesota for $50,000. This company will in the future manufacture their own goods under the trade mark "U. S." The officers of the company remain the same.

The Department of Commerce, Bureau of Census, Washington, D. C., has issued an interesting Summary of the Gas Industry for 1914. The summary shows some interesting statistics; for instance, the increased production of acetylene gas in 1914 as compared to 1909 was 448 per cent in volume and 595 per cent in value of the 138 million cubic feet of acetylene manufactured in 165 acetylene plants in U. S. in 1914. 115½ million feet or 83 per cent was manufactured in the 36 compressed acetylene plants in the U. S.; 15,875 tons of calcium carbide was used in 1914 as against 3,040 tons in 1909.

The report deals principally with fuel gases and contains very interesting information.

Welding shops should carefully preserve all scrap metals. When the quantity on hand is large enough good prices can be obtained.

Hints for the Welder

Practical suggestions from practical men. Contributions to this department solicited.

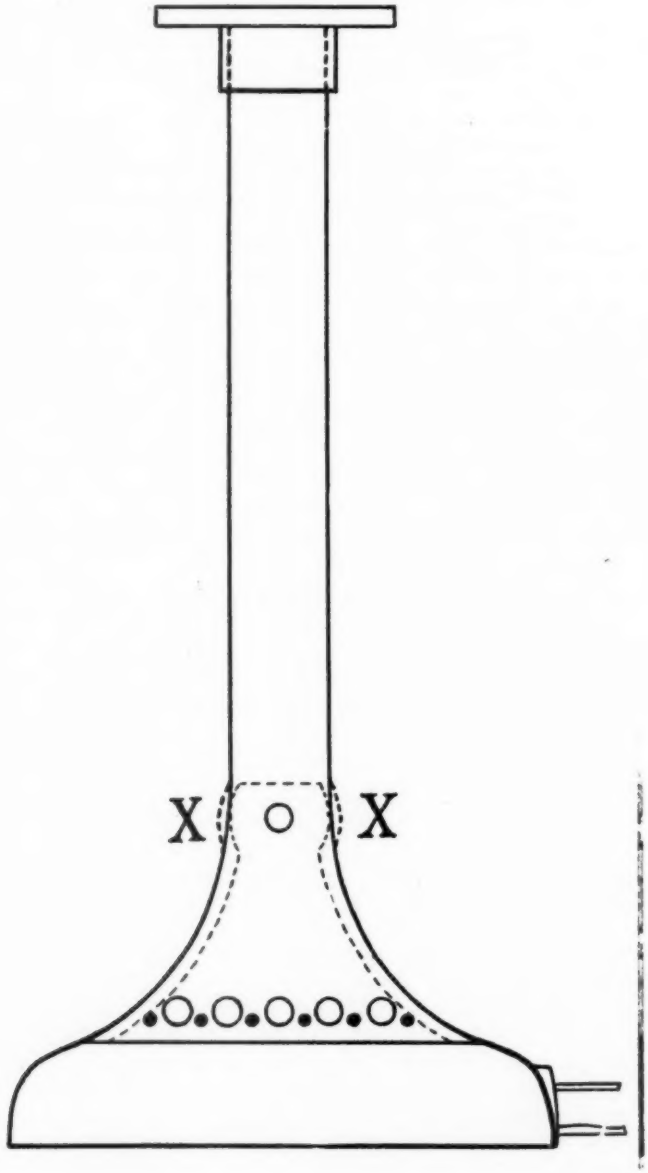
WELDING A ½ FORD HOUSING

Editor:

Should you care to pass this on, I feel sure it will do some one some good, as I failed on this job a number of times before I figured this out.

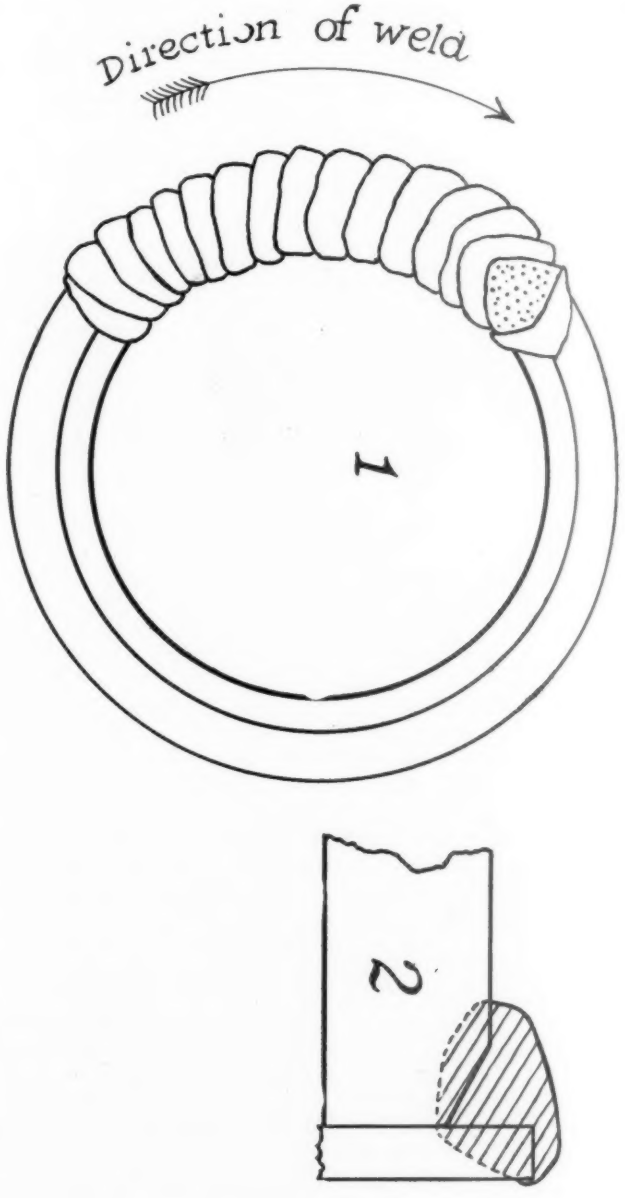
When the rivets in this housing give out it usually bulges the housing tube at x, the seat of the malleable casting. Riveting or common brazing will not hold. To make this job O. K., I take it apart and clean well. Then drill 11/16 holes between rivet holes and also three 11/16 holes at x through housing tube in each case to seat of joint. Then I preheat and braze edge of tube to malleable casting, leaving holes until last, to take care of contraction. C. R. HAMMOND.

130 North 23rd St., Salem, Oregon.



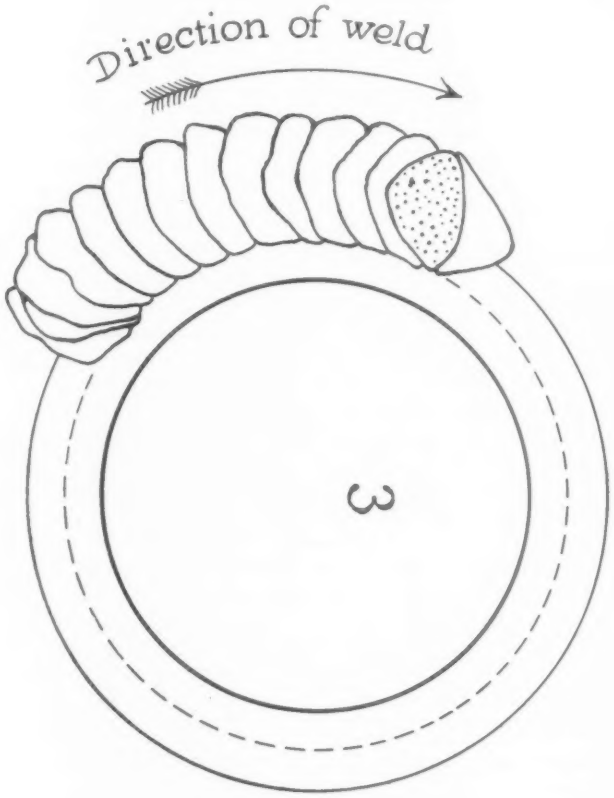
Editor, *Welding Engineer.*

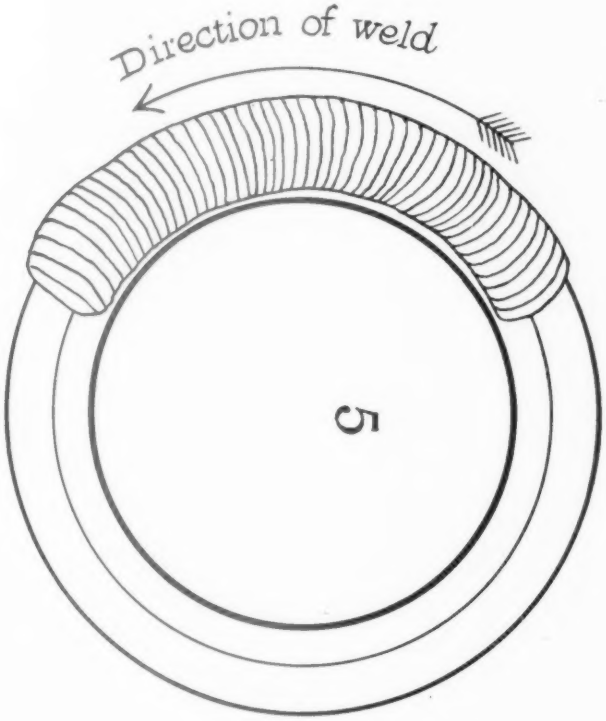
Sir: In the article appearing in your May issue on Flue Welding by Electric Arc Process, no real evidence has been submitted which would enable locomotive engineers to appreciate the causes of cracked bridges and the unsatisfactory state of the art of welding flues in locomotive flue sheets, is due to the methods employed.

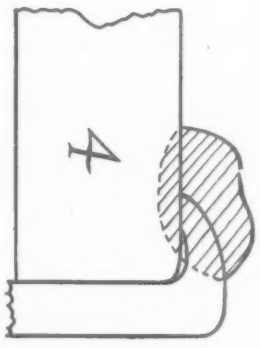


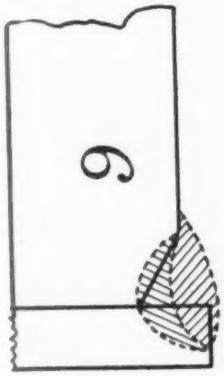
In welding flues by the means of the bare wire process, the electrode is deposited upon the flue sheet and to do this the flue sheet and flue, at the point of welding, has to be brought to a fusing temperature so that some sort of adhesion might take place between the flue sheet and the added metal. The flue sheet is expanded owing to this great heat, and the deposited metal has to shrink in cooling, such shrinkage being somewhere about $\frac{3}{16}$ of an inch in one foot. This shrinkage has to be taken care of, with the result that the original metal and the added metal are stressed one against the other, and there is a resultant move in the body of each until these forces are balanced. The added metal is molten metal frozen, and the fused original metal is frozen metal raised to a fusing point. As is well known molten steel that has cooled is good metal, but steel that is raised to just under fusing point is completely and irretrievably spoiled until remelted. The deposited metal is fused to steel that has been ruined, due to its excessive heat treatment, therefore the shrinkage of the deposited metal which is not spoiled, owing to its heat treatment, and also by reason of its volume, is better able to take care of its internal strains than the spoiled surface of the original metal to which this deposit is attached.

These strains in and about the welded metal are borne by the original metal for a short time and then the superheated surface develops a crack. This crack, as we all know, will extend through the body of the metal and then the bridge will at last, but surely, crack right through. To overcome the heating of the flue sheet, locomotive engineers have welded the flue sheets after previously filling the boiler with cold water. There is an advantage here, inasmuch as the deteriorated excessively heat treated original metal is a little more restricted, but the trouble is practically the same. A solution to this would be to lay down a deposit in a very thin layer not more than $\frac{1}{16}$ inch at a time; obviously with the bare wire electrode this is quite impossible. It is also necessary that the surface of the original metal be fused in such a way that the surface is only fused and the body of the metal remaining at a temperature which is considerably less than that of the critical stage. This cannot be accomplished when the electrode is applied in such a way that the weld is started from the bottom and working upwards. In welding this way, it will be observed that the metal thus deposited will have a tendency to run down and running away from the already fusing original metal. The deposit must necessarily be at least $\frac{3}{16}$

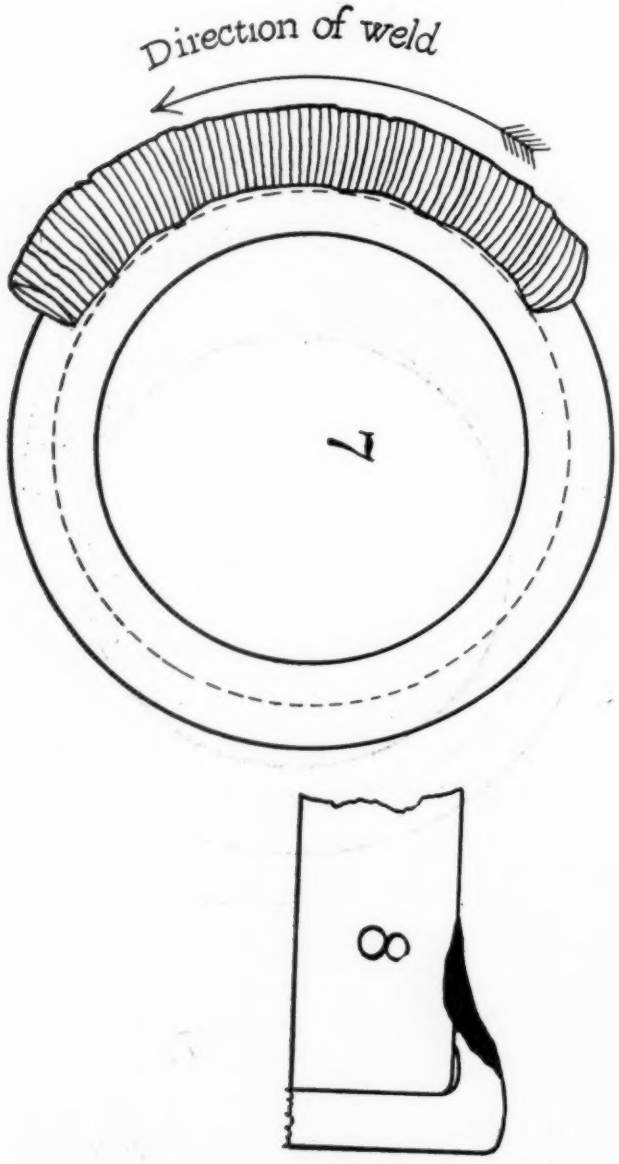








inch to ¼ inch thick at the thickest place. There are two defects here: First, the surface of the metal must be heated for a longer period than is necessary to make the surface of the metal sufficiently molten so as to give a bath great enough to allow a fusion between the deposited metal, which has drained down, and the original steel. Secondly, the deposit is too heavy. Mr. Bryan, in his article, points out that the voltage at the arc in this class of welding is of paramount importance, and that a difference of three or four volts across the arc will affect the situation, and that the closer the electrode is held to the job the better will be the result. This is true; but the reason why a better job is accomplished is due to a short arc and not so much to the electrical conditions (voltage) but rather to the arc flame.



By holding the electrode close to the job a "squashed" arc effect (I have coined this application of term because it explains my meaning) is obtained, which is the true reason as will be explained. The electric arc is one of the strongest reducing flames known, and steel, from its critical stage up to its point of fusion, has a very nasty habit of absorbing oxygen and combining with the iron and carbon, etc., to the detriment of the steel.

In drawing a long arc, the surface of the metal is protected from the atmosphere, but the arc cannot be controlled, and at one period the metal is protected and at the next it is not, owing to the changing position of the arc. By shortening the arc until the electrode is almost touching the work or the deposit, it will be observed that the arc is protecting the surface of the fused material to a greater degree; therefore, the deposited metal is freer from the influences of oxygen and other harmful gases. The voltage of the arc, of course, varies in accordance with the length of same, and for that reason Mr. Bryan's remarks as to three or four volts of the arc affecting the situation are accurate but, as aforesaid, not the real reason.

The solution of the above troubles would be a very speedy fusing of the surface of the steel, a very thin deposited layer of the deposited metal and the original metal, at all times, protected from the influences of the atmosphere. This can only be accomplished by duplicating steel bath conditions, that is, by the use of slag.

An electrode has been developed whereby this desirable condition can be obtained. The steel core of any desired composition is wrapped, around its exterior, with a special form of acid slag, and in application this electrode is kept in actual and physical contact with the work during its entire period of fusion. The arc, for this reason, is very small and decidedly squashed. The arc is formed by the slag becoming vaporized and is not at all similar to the generally recognized electric arc. The slag covering of the electrode has the effect of directing the flow of both the core and the slag, and the arc effect in the fusing end of the electrode is operated in line of the direction of application. The slag melting at a much higher temperature than the molten metal, naturally freezes or becomes plastic at a temperature when the steel is still molten. Therefore, in using this special form of electrode and for vertical welding, or for the welding of flues, which is vertical welding, the electrode is held at 90 degrees to the work and is started at the top of the flue and worked downwards directly opposite to the usual bare wire process. The metal thus deposited has a tendency to run down and naturally runs upon the already fused surface of the original metal. The metal is stopped from running too speedily, by the slag covering. This slag covering passes from the end of the electrode onto the work in a fluid state and protects the surface of the original metal and the deposited metal from atmospheric effect. In fact, when the slag is removed, the deposited metal is bright like burnished silver.

The deposit can be made of extreme thinness, $\frac{1}{32}$ inch or less, and by reason of the intense local heat of the arc and its speedy application, the surface of the original metal is not disturbed by more than about 1/100 inch deep. Yet a complete and absolute fusion takes place between the surface of the original metal and the deposited metal due, of course, to the true steel bath condition. With this special form of electrode, a locomotive flue tube, not a superheater flue tube, can be welded in 35 seconds, whereas, to weld one of these tubes with the bare wire method, would probably take from 2 minutes to 5 according to the skill of the operator. After welding by this special electrode, the hand may be placed upon the welded flue without the surface of same being at all uncomfortably hot. In welding flues, as shown in the sketches, the best means of welding flues will be readily appreciated and the reasons thereof.

Figure No. 1 shows the flue sheet chamfered, the flue tube protruding and the flue and flue sheet welded by the means of the bare wire system.

Figure No. 2 shows a cross section of this flue and the shaded portion representing the added metal due to welding. As pointed out previously, this deposit is of much greater cross section than the disturbed metal, even though same is as great as $\frac{1}{8}$ inch or greater, which unfortunately it

sometimes is. The tendency of this weld in shrinking is to become smaller in its circumference, therefore the weaker metal must give way, which it does by cracking, and as the weaker is the original metal, a crack is started in the bridges.

Figure No. 3 shows a beaded flue that has been welded on the outside of the bead by the means of the bare wire method. Figure No. 4, cross-section of same. In this instance the deposit is not upon quite such a dangerous place as the edge of the bridge, but nevertheless a crack is started almost in the center of the bridge and must necessarily proceed latterly.

Figure No. 7 shows a section of the flue sheet with the flue in place and beaded and the outside edge of the flue welded to the flue sheet by the means of the Quasi-Arc weldtrode, which is the special weltrode referred to previously. As will be observed, the electrode has been started at the top and worked to the bottom, and it is then started at the top and worked to the bottom on the other side; total time 35 seconds.

Figure No. 8 shows a cross-section of this weld and the very thin metal of the deposit which is amply strong enough for the job. The shrinkage of the metal, owing to its narrow cross-section, is readily taken up within itself and by reason of the metal being fused underneath the special form of slag, the metal is extremely pure and has all the attributes of ingot steel, therefore highly ductile.

Figure No. 5 shows a portion of the flue sheet and flue in position. The flue seating having been chamfered to duplicate the welding as shown in Figures Nos. 1 and 2.

Figure No. 6 shows a cross-section of this flue sheet and weld. Two layers have been made, as will be seen from the shaded portion. The object of two layers is to reduce the strain on the bridges and allow each thin layer to take care of its own shrinkage strains. This deposit, of course, could be made in one layer, but the shrinkage would have to be taken care of and it would necessarily set up a heavy strain in both the weld and the original metal, which would be, as pointed out previously, unwise. The most satisfactory form of flue sheet weld is to bead the tube and weld the exterior by the No. 10 Quasi-Arc special weldtrode.

For that purpose see sketches Nos. 7 and 8.

The current can be either D. C. or A. C., preferably at 100 volts on the line, although the arc voltage is approximately 30. The reason why it is preferable to have 100 volts on the line, is that in starting the higher voltage enables a quick start to be made and in joining up the two welds there is no tendency to get an indifferent start. It is quite possible to use these weltrodes on a voltage of 30. The amperage should be about 120; alternating current is preferable to D. C. and when D. C. is employed it is essential that the work be the negative pole and the electrode the positive pole, which is again opposite to the bare wire method. The reason why the polarity is arranged thus is because the positive pole is the hottest side and it is one of the features of the process to keep the work as cool as possible, and depend upon the very high localized effect of the heat to create a complete fusion.

Welds made by the means of these special electrodes have not failed and cracks in the flue sheets have never been present. Bridges can be cut out and built up anew by the means of this process and give a weld which is strong enough to withstand expanding to more than ¼ inch over size. This is, of course, unnecessary, but it was a test this weld has been subjected to.

P. A. E. ARMSTRONG,

Quasi-Arc Weldtrode Company, 61 Broadway, New York, N. Y.

PATCHING BOILERS

Editor:

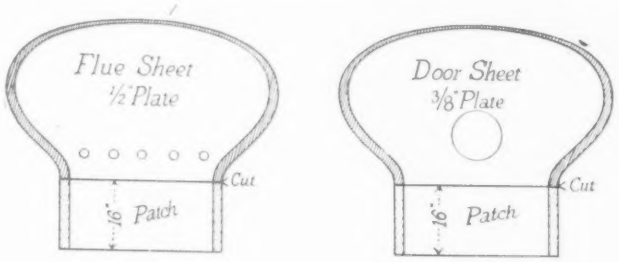
I am sending in a sketch of a job I have done and a job I am at present working on. If you could favor me with any information regarding same I shall be most pleased to receive same.

J. RENTON.

Lansing, Mich.

Answer:

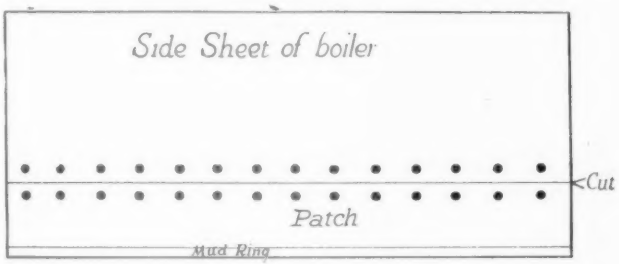
The patches in the door and flue sheets should be extended



on the ends to reach the center, between the first and second row of staybolts in side-sheets, where they should be welded.

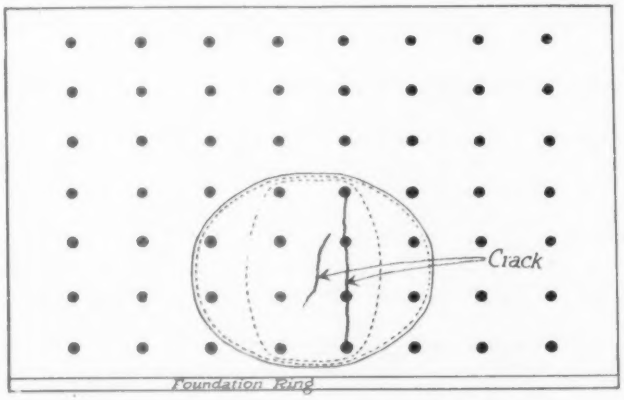
The width of the patches should be so cut that the bevelling line will cross the four rivet holes on the flue and door sheets. The corners of the patches should be rounded.

After the edges are bevelled to a 45-degree angle, apply



patches about 1/16 inch clearance on one end and separate on the other end, about 3 per cent of the length to be welded.

The best method of holding the patches in place is to clamp them with C clamps to the mud ring about every 12 inches. If bolts must be used, then use ½-inch bolts with washers on



Center Sheet of Belpaire Boiler

the ends. When clamps are used, they may be left on until completely cold. When bolts are used, they should be removed or loosened one at a time, in the course of the welding operation.

Commence to weld from the closed end, and while the welding is continued the edges will approach each other, and when the extreme end is reached both edges will be closed.

To increase the strength of the weld, anneal and hammer the line of welding; care should be taken not to hammer the weld at too low a temperature; the metal must be a bright cherry red when hammered.

The side sheet patch should also be rounded at the corners and applied the same as above. Commence to weld from one end and advance steadily until the extreme end is reached.

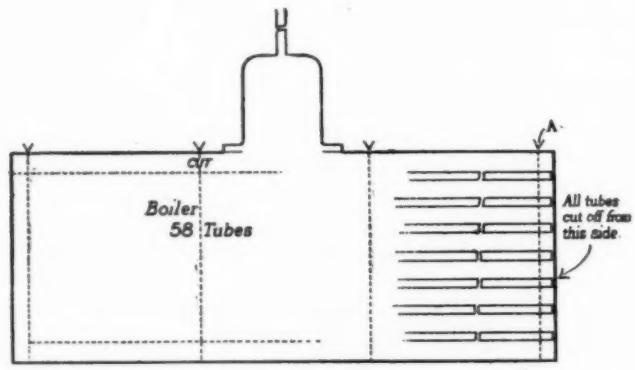
The patch in the center sheet already welded could be greatly improved by cutting the patch entirely round, as per attached sketch, instead of oblong, and same patch should be dished. Thus, in cooling, it would straighten again and will not leave any strain that may break afterwards.

Another method to weld cracks between stay-bolts is to drill 5/8-inch holes, one near the other, all along the crack and then weld up the holes.

There is still another method that is the most successful for some kinds of cracks. Heat the edges of the crack with a blow-pipe previous to welding, and hammer edges out towards water space, as per illustration, until 1/8 inch clearance is left between edges. Then weld up the space until it is even with the surface of the sheet. If an oxygen blowpipe is used, a No. 10 welding head with 9 lbs. oxygen pressure will give the best flame for boiler work. Editor (K).

CUTTING UP BOILERS

About sixty days ago a kind reader sent us a sketch and description of his method of cutting up a boiler. The description which accompanied the sketch has been lost and the Editor would like to hear from the author.



QUESTIONS AND ANSWERS

Editor: (1) We wish to know through your columns how to go about welding 3/8 inch boiler steel where rivets have been sheared off due to expansion. This job is the abutment of a railroad bridge. Water ran down between the concrete and froze and rivets of top sections sheared, sections being five feet long. Can they be welded without beveling and will concrete behind plates make any difference?

(2) Why don't we have better success with our malleable iron welding? We have too many jobs come back on us. We emery off all the rust and clean all parts well and run manganese bronze into the cracks. We do not overheat. We use a special brazing flux, but have had just as good results with borax.

(3) Can we weld automobile springs successfully and what kind of material should we use?

Answer: (1) If the plates still lap say 1/4 inch you can weld by simply adding a fillet. If the plates are pulled apart a bevel will be necessary. The concrete will not affect the job.

(2) On page 41 of the April issue an article was printed on the subject of welding malleable castings. This article, together with some comments by S. W. Miller, M. E., printed on page 34 of the March issue, is being sent you under separate cover.

(3) Elsewhere in this department, this issue, your question relative to welding automobile springs is answered.—Editor.

Editor: Can you tell me where I can get a market for copper, brass and aluminum junk? I have a bunch of it in my shop and want to get rid of it while it is worth something.

Chenoa, Ill. C. W. HEINE.

Answer: Under separate cover we send you a list of concerns dealing in this material. We would advise you to ask for prices. Weigh metals very carefully before shipping.—Editor.

Editor: In your May issue you described a process of welding Stellite to tool steel. What machine does this refer to and what material is used as one of the electrodes?

Montreal, Canada. J. D. LACHAPELLE & CO.

Answer: The arc welding process described in the May issue refers to an arc welder manufactured by the C & C Electric & Mfg. Co., 600 ampere. Swedish iron is used as one of the electrodes for filling in.—Editor.

Editor: We are sending you a photograph of a centrifugal pump we successfully welded recently. The pump was 60 inches in diameter, with a 48 inch crack. Since welding the pump has been in operation two and one-half months, night and day, pumping about two hundred and fifty tons every twelve hours. This was an emergency job and illustrates the adaptability of the oxy-acetylene process. A Vulcan outfit was used.

FORT MEADE WELDING CO.

Fort Meade, Fla.

Editor: What would be the best filler rod to use in welding automobile springs? I have been using Vanadium steel. Is there anything better?

Anadarko, Okla. W. W. SMITH.

Answer: We believe the welding of automobile springs is one of the most difficult tasks the welder is confronted with. In our March issue Mr. S. W. Miller, M. E., Rochester Welding Works, said: "The writer believes it impossible to weld high carbon steel without burning it, and the higher the carbon the greater the danger for two reasons: the steel is partly decarbonized and is always burned, the writer believes, next to the weld. Microscopical examination of such welds prove this. * * * It is true that such a weld may be at times strong enough to stand the strain to which it is subjected, but it is not a perfect job by any means. * * * It is at times possible to produce a satisfactory job on springs, but there is always the chance that the work will be unsatisfactory. The most important thing, however, in welding any grade of steel is that the heat changes the structure in the vicinity of the weld, making it weaker than the original material. * * * This ing operation is finished, but the original strength and can be partly overcome by heat treatment after the weld- other physical qualities can never be entirely restored."

The Editor of *The Welding Engineer* recently consulted the superintendent of a big Chicago welding shop on the subject of welding automobile springs. This gentleman said that in the past he had been successful in welding springs from old White cars, the break in every case being in the goose-neck and not in the leaves. Not long ago he welded a spring in his own car, the job looking very good. A few days later the spring broke and he found himself and family 180 miles out of New York in a very annoying

situation. He will not undertake to weld automobile springs now.

We believe if you take a job of this kind Vanadium steel rod will answer as well as any filler rod you can use. The spring should not only be retempered, but annealed as well, and this requires the necessary equipment.—Editor.

Editor: I have read the article about a welding association. I believe that is just what is needed. Through your paper you have already improved the welding trade. Since I have read your paper I have gained knowledge in copper, brass and aluminum welding. The superheater article in the last issue also served me well, as I had a similar job.

Jackson, Mich. JAMES P. MAULT.

Editor: Will you be good enough to tell us what you know of the "Castolin" welding process?

This process originates from France. With the aid of what appears to be paste, together with a blow torch, they are able to weld anything from a darning needle to castings of heavy tonnage without any preliminaries by way of chipping, etc.—merely sticking the edges together, applying the heat, and presto! we have a weld that will defy breakage—at least we are told this. We would like to know something further about it.

COMPRESSED GAS CO., LTD.

Vancouver, B. C.

Answer: We have never heard of this process, but would be glad to hear from any reader who can give us information.—Editor.

Editor:

I would like to see welders get together on this new proposition which was brought up for attention in your last issue, as it will not only help the boys to do better work, on account of one helping the other by way of suggestions, but if founded right will keep a good many people out that are always inclined to kill things; that is, by doing inferior work, so the public losses faith in what can be done with a welding flame.

LEON G. STARK.

Universal Welding & Sheet Metal Works, Madison, Wis.

Editor:

To cut a hole through chilled steel or rather chilled cast, use a cutting tip. We had a pair of shoes off a locomotive to drill holes through, and this is the way we did it. We first heated them up in the forge to save gas.

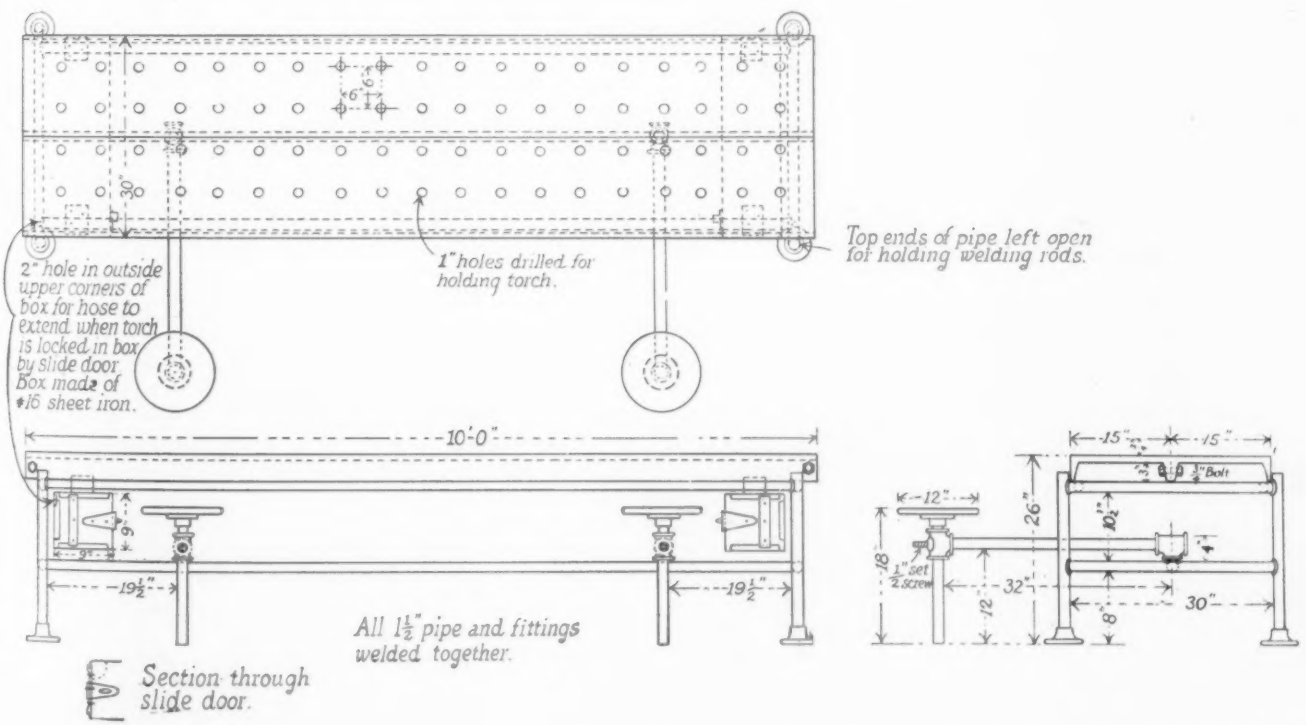
SANDERS MOTOR CO.

Shelbina, Mo.

THE FIXED RESALE PRICE

Many effective arguments in favor of legislation permitting manufacturers to fix the prices at which their products may be sold at wholesale and retail were presented at hearings on the so-called Stevens bill before the House Committee on Interstate and Foreign Commerce at Washington in the past week. The hearings followed closely the referendum of the Chamber of Commerce of the United States, in which the maintenance of resale prices was advocated by a vote of three to one.

In sharp contradiction of the assertion of its opponents that champions of the Stevens bill are confined to a relatively small number of manufacturers of trade-marked goods, nearly all the witnesses before the House committee represented national organizations of retailers or consumers. The argument that has carried the strongest appeal to Congressmen is put forward from the consumer's standpoint and deals with the protection enjoyed by the consumer in the ability to purchase identified merchandise in any market. The assurance to the consumer guaranteed by the well-known brand is worth more, it was contended at the hearings, than the doubtful temporary advantage of the cut price; hence the argument that Congress in permitting the manufacturer to protect the prices of his trade-marked goods is legislating as much in the interest of the consumer as of the producer.—*Iron Age.*



Good tools are essential in the welding shop. This model welding table was designed by Mr. B. Kopferschmidt, Michigan Central Railroad, Jackson, Mich.

Welding of Broken Automobile Parts

The Repair of Broken Automobile Parts Is a Very Important Part of the Work Brought Into the Average Shop—This Article Contains Much Information of Value

By Harry B. Hoover

In the welding of broken automobile parts it is very essential to get them in perfect alignment. To do this care must be taken in preparing them for welding. Contraction, expansion, warping and shrinkage must be looked after with the greatest of care.

In welding a broken exhaust manifold as shown at A in Fig. 1 it is absolutely necessary that it be in perfect alignment and as it is broken entirely in two it is somewhat difficult. The shrinkage will take care of itself in this case, but the chance of warping is rather great.

To prevent warping the manifold should be clamped onto a straight edge about 1 inch square and as long as the manifold, and not onto a face plate, for in making the weld the manifold must be turned over, as it is necessary in making a weld in cast iron to keep the weld as level as possible. By having the manifold clamped onto a straight edge it can be turned at will without any danger of warping or getting out of alignment, but if it was clamped to a face plate it but put manifold, straight edges and all, into a box of lime or ashes, cover up and leave until cold. This will leave the weld soft, so that it can be filed very easily. After removing the straight edges it will be found that the part of the flange that was broken off is just a trifle higher than the rest of the casting; this is due to the paper being placed under the flanges. A little filing will bring the high part down even with the rest. In this way a perfect job is obtained.

Never clamp work of this nature onto a face plate for several reasons. First, it could not be turned as would be necessary to meet conditions. Second, because the heavy face plate radiates the heat out of the weld almost as fast as it is applied. Therefore it would be impossible to make a successful weld, as it would be full of blow holes and would not amalgamate properly. To make this weld at all it would be necessary to use a large sized tip, which would cause a waste of gas and time, to say nothing of the rough

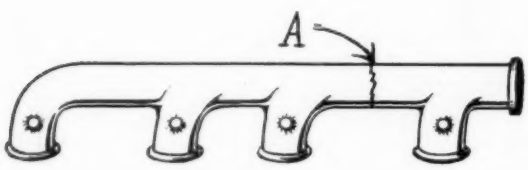


Fig. 1

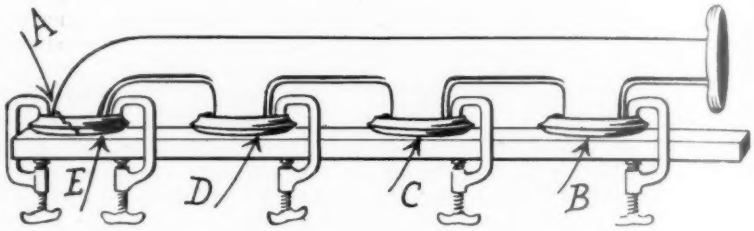


Fig. 2

would be necessary to take it loose, so as to finish the weld on the under side. In doing this the manifold would be subjected to conditions that would be apt to warp it, sometimes considerable.

In making this weld it should be tacked or spot welded in at least three places, before starting to make the actual weld. Then start and weld entirely around the casting, finishing at the place where started.

A manifold broken as shown in Fig. 2 would be aligned up for welding somewhat different to the one in Fig. 1. This one will not only warp but the shrinkage must be allowed for. The contraction and expansion will take care of themselves in both of these jobs.

To prepare this manifold use a straight edge about 1 inch square and as long as the casting; five clamps should be used. Slip two pieces of newspaper between flanges marked B, C. D; also under the part of flange at E that is still on the manifold; then place the broken part in position and clamp it down, but do not use any paper under this part. In doing this it lowers the broken off part the thickness of the two sheets of paper; this allows for the shrinkage in the metal. Tack the weld at one edge, then start at the other edge and weld around to the first tack. This weld can be made entirely from the outside and a small fillet should be built up on each side of the hole; this will strengthen the weld and will not intefere in any way.

After the weld is finished do not take off the straight edges, job it would make. Then again, if it was removed from the face plate (after being tacked) to relieve this trouble, the manifold would warp out of alignment which would necessitate it being put in a planer and machined up.

Cylinders with the flanges broken as shown at A in Fig. 3 would be handled in the same way as the manifold in Fig. 2. The contraction and expansion will take care of itself in this case also. All of the welding should be done from the outside, so as to eliminate the machine work on the inside or bore of the cylinder as much as possible. Cylinders that have cracked water jackets as shown at B in Fig. 3 will have to be preheated and cooled properly to take care of the contraction and expansion. A great deal of precaution must be used to prevent the warping of the cylinders out of round and to keep a scale from forming on the inside of them, thus enlarging the bore and causing them to be oversized.

The way to handle this cylinder is to first strip it of all working parts, valves, valve springs, valve plugs, pet cocks, etc., then take oil and graphite, or a stick of grease graphite (the latter is best) and cover the bore of the cylinder with it. This will prevent it from scaling. Next place the cylinder on a forge or welding bench, bottom side up and build a furnace around it with brick, leaving 3 inch or 4 inch space all the way around, and as high or higher than the cylinders, leaving a space of 1½ inches or two inches between the bottom brick to allow for draft. Lift the cylin-

ders out and put about 2 inches of charcoal in the bottom of the furnace, replace the cylinder, placing it on the top end as before. Fill in around with charcoal and use the welding torch to start it to burning by throwing the flame into the openings between the bottom brick. After the charcoal has a good start it will burn from the draft. Then cover the top with thin asbestos paper. This holds in the heat. See that the fire burns evenly all around in order to get an even heat on the cylinder. By putting it on end as above mentioned the chances of warping are eliminated, providing there is an even temperature kept on it. Where the cylinder lies on the side it is almost impossible to heat it evenly, therefore it would be almost sure to warp, especially if it is brought to a red heat.

It will not be necessary for the charcoal to come up any higher than the water jacket. Bring the cylinder up to or almost a dull red heat, then remove the cover and the top row of bricks, turn the cylinder with the crack up, or that portion that is to be welded. Cover again with the asbestos and cut a hole in it over the crack, just large enough to permit the welding to be accomplished. This protects the operator and at the same time holding in the heat. The weld should be made as quickly as possible; if the cylinder is badly broken and it is necessary to turn it considerable, it is apt to become too cool. In an instance of this kind, the cylinder should be set up again and more charcoal added to the fire and heat up again. If it cools off too much the uneven contraction will cause it to crack. After the proper heat has been attained, finish the weld. Again set the cylinder on end and put in more charcoal, bringing it up to an even heat. Place the brick together at the bottom and tuck in the asbestos, closing up the openings and preventing any cold drafts from striking the cylinder. It should remain this way until it is perfectly cold.

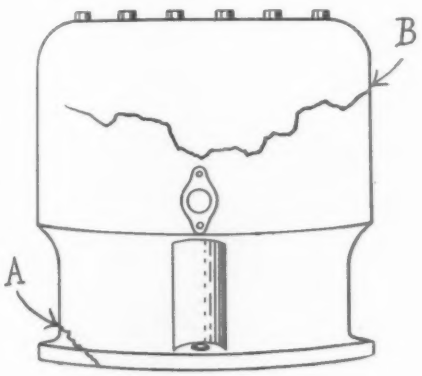


Fig. 3

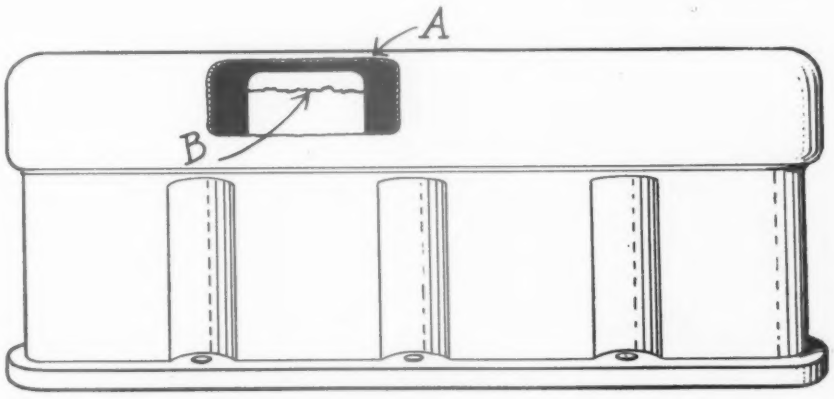


Fig. 4

A cylinder with the head cracked or broken out as shown at B in Fig. 4 is rather a difficult job. (The opening in the water jacket indicated by A was made so that the inner cylinder could be reached.) There are two ways of making this weld. One way is to cut the water jacket off from around the cracked or broken out head. This can be accomplished by dulling and using a hack saw. The opening should be cut large enough to allow the operator to reach the fracture with ease. If the head is broken entirely out it should be fitted and spot welded into place before putting the cylinder into the furnace to be preheated. After the water jacket has been cut away and the head tacked in, the cylinder should be placed in a furnace or oven, the same as explained for the cylinder in Fig. 3. (It should be large enough to allow the cylinder to be turned on its side or in any position most convenient to weld.) Place the cylinder bottom side up. This brings the fracture down into the fire, charcoal being used as a fuel. Keep the fire burning evenly and up above the water jacket.

When the cylinders are at the proper heat (which should be a dull red) turn them over and weld in the head; then set it on end again, put in more charcoal and bring it up to an even heat, closing the opening between the brick and tuck the asbestos in tight around the cylinder, and leave until perfectly cold. After the cylinder is cold the weld can be tested by turning the cylinder bottom side up and pouring in a little gasoline. If there are any cracks or pin holes in the head the gasoline will seep through. If there are any defects in the weld it will be necessary to preheat the cylinder again and the defects welded up, cooling and testing in the same manner. When the inside weld is finished the water jacket can be welded on. First tack or spot weld it in place, then preheat as before. After finishing the weld allow it to cool slowly.

To test a cylinder after the water jacket has been welded, plug up all holes in the jacket except one and, if possible, couple this opening up to the city water, and if it will stand this pressure it may be assured that the cylinder is in good condition. If a water connection is impossible, fill the water jacket with water and use air pressure instead, a few pounds' pressure being sufficient.

The other way to weld the cylinder shown in Fig. 4 is to weld it entirely from the inside. However, this cannot be accomplished with all apparatus, but where it can be, it is just as practical and more economical. If the head was broken entirely out, a cast iron filler rod can be welded onto it in the center. It can then be put in place and held until it is spot welded. The rod would then be melted loose from the head and the cylinder would then be ready to weld. It would be handled or taken care of in the same manner as the ones before mentioned.

Charcoal as a Fuel

The writer finds that charcoal is the best and most economical fuel to use in the welding of cylinders or any cast iron parts where the contraction and expansion has to be taken care of by preheating. It lights very easy, needs only a draft to make it burn, retains a steady even heat and does not require much attention. Some operators use gas or gasoline for preheating in the same kind of a brick oven or furnace as when charcoal is used. The burners used mostly in these instances are pipe drilled full of holes, this being more economical than the gas blow pipe, as the latter requires compressed air. The heat in these gas ovens is regulated by turning the flame up or down. This requires a lot of

attention and it is almost impossible to keep it at an even temperature, for if the flame is turned too much one way or the other it will either heat or cool off too rapidly, and again, the heat is not evenly distributed through the furnace, and this would cause the cylinder to warp very easily. More cylinders are ruined this way (warping) than any other. If a cylinder cools faster on one side than on the other it is not only apt to crack from the uneven contraction but it is apt to warp. Taking everything into consideration charcoal is far more practical and economical than any other fuel.

The writer finds after years of successful experience that if these suggestions are closely followed that there would be very little or no trouble in this class of welding.

ODD JOBS IN A MANUFACTURING PLANT

By Gordon Fox

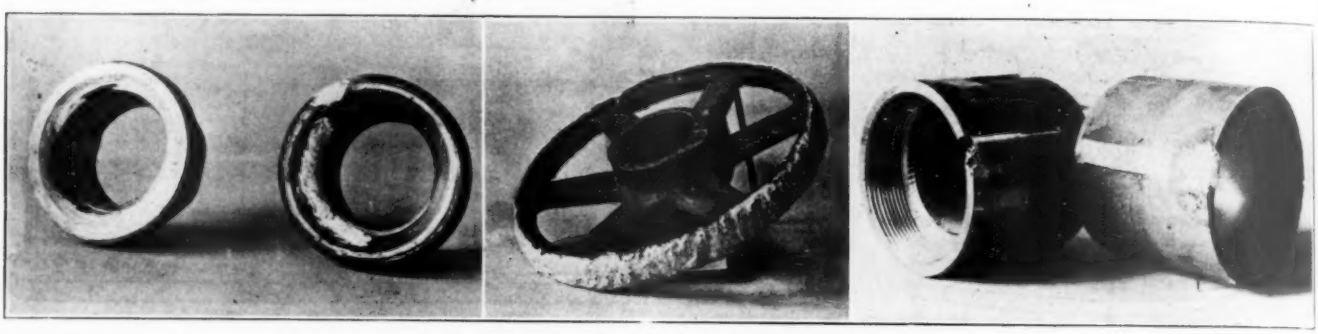
The salesman of welding apparatus often find it difficult, no doubt, to impress upon a prospective customer that he does not appreciate or realize the opportunities which will arise for the use of the welding torch after he is equipped with an outfit. It may, therefore, be of interest to set forth a log of odd jobs done about the plant in an actual case.

About the middle of February, 1916, we purchased a small welding torch for use in a manufacturing process to reclaim defective parts. For this application the flame welding has been entirely successful, but will not be discussed here, as it represents no unusual conditions. It might be mentioned, however, that the process has been extended to other products of the plant so that a good many defective castings and other parts are now sent on to completion, instead of being relegated to the scrap heap.

Returning to our story; after the outfit had been in use a few days "possibilities" began to crop up. Partly for the sake of experience we tried our hand at them, after absorbing the literature on the subject. Every attempt but one resulted in a satisfactory outcome, a thin, flat casting having cracked in cooling, too badly to be worth further effort. In each case we estimated the net saving by welding, over other means of repair or replacement. This saving in a period of a little more than two months has been about $70.00. This applies to the odd jobs alone. The saving upon defective product has been many times this amount. In order to illustrate the variety of small jobs which have been done, I attach a list herewith. I also present photographs of two classes of defectives being reclaimed together with one of our "odd jobs."

Memorandum of Welding Jobs

Feb. 16—Inserted material for new tooth in bevel gear for drill press. Avoided several days' delay.
Feb. 17—Repair broken casting from office chair.
Feb. 19—Annealed die locally to permit machine work.
Feb. 29—Repair dividers for tool room.
March 3—Heat jammed die locally to expand and relieve. Worked after other methods failed.
March 6—Welded broken casting on drill press. Saved making new pattern, casting and machining.
March 7—Repair cracked bronze casting on electrical machine.
March 10—Built up metal on two worn cams. Avoided scrapping and making new.
March 10—Preheat fender rods on automobile to straighten same without removal.
March 10—Weld broken alligator wrench.
March 11—Weld broken handle casting on press. Avoid making pattern—casting and machining.
March 16—Weld broken clutch casting on drill press. Avoid making difficult pattern, casting and machining. Avoid bad delay.
March 16—Weld cracked hand ax for tool room.
March 24—Fill hole in cast iron mold.
March 29—Heat locally connecting link of press previous to straightening same.
March 30—Build up metal on worn clutch pulley for machine shop. See photograph.
March 30—Repaired lathe gib.
April 4—Fill rough spots in iron mould.
April 4—Repair broken jig. Welded steel ring.
April 10—Filled holes in jaws of special machine.
April 25—Welded metal pail.
April 28—Welded broken vise.



April 29—Welded top onto drill shank. Tip was broken off.
May 2—Built up jaw blocks of milling machine.
May 3—Welded shanks onto a number of stub drills.

RADIUM NEVER SEEN IN NATURE.

Radium is a metal and is described as having a white metallic luster. It has been isolated only once or twice and few people have seen it. Radium is ordinarily obtained from ores in the form of hydrous sulphate, chloride, or bromide, and it is in the form of these salts that it is usually sold and used. These are all white or nearly white substances, whose appearance is no more remarkable than common salt or baking powder. Radium is found in nature in such exceedingly small quantities that it is never visible even when the material is examined with a microscope. Ordinarily radium ore carries only a small fraction of a grain per ton of material and radium will never be found in large quantities because it is formed by the decay of uranium, a process which is wonderfully slow, and radium itself decays and changes to other elements so rapidly that it is impossible for it to accumulate naturally in visible masses. Minerals that carry radium, however, are fairly easy to determine. One of them, pitchblende, as generally found, is a black minereal about as heavy as ordinary iron, but much softer. The principal radium mineral, carnotite, has a bright canary-yellow color, and is generally powdery. There are other radium-bearing minerals of less importance.

The Technical Production of Hydrogen

Recently the Editor Was Asked for Information on This Subject—The Following Article Is Reprinted from a Booklet Published by the Author

By Harry L. Barnitz, Ph. G.

Prior to the year 1907 little importance was given to the technical production of hydrogen gas. Since then, however, the application of hydrogen gas has been continuously and rapidly extended. With the development of the dirigible airship in Germany, it was imperative that hydrogen be cheap and easily obtainable in large quantities. Accordingly the development of the airship may be considered the chief stimulus in the technical production of hydrogen. Germany, France and England have been the principal countries to first utilize the gas commercially. To Germany credit must be given for being the first, not only in developing its technical production, but also in extending its application. In the United States, hydrogen is continually increasing in importance in the industries, but prior to 1913 only little was used.

For the autogenous welding of steel, cast-iron, wrought iron, copper and aluminum and its alloys, hydrogen in combination with oxygen is finding continued increasing application. Hydrogen here presents the great advantages of wide applicability, cleanliness, and cheapness. Another use which is constantly extending is in the cutting of wrought iron and steel. The oxy-hydrogen flame will cut metal up to 24 in. in thickness. In the cutting process considerable excess of oxygen is required, whereas in the welding process a reducing gas mixture is used. The cuts are cleaner than those of a saw, and even in thick metal are only ⅛ of an inch in width. The rapid extension of the cutting practice by the oxy-hydrogen process is due to its convenience, simplicity and cheapness. The oxy-hydrogen flame is also used for melting quartz and platinum in lead burning, in the manufacture of synthetic jewels such as ruby and sapphire, and in many other technical processes.

In the manufacture of electric lamp filaments hydrogen finds further employment. Large quantities are used in the reduction of tungstic acid and in the sintering and fusing of the tungsten metal powder into rods.

Hydrogen produced by the silicon, aluminum and other similar processes costs from $5.20 to $6.85 per 1000 cu. ft. These processes have been displaced by practically three patented processes known as the contact-process (iron process), Rinker-Wolter process (oil process), and the Linde-Frank-Caro process (water gas process). The cost per 1000 cu. ft. varies from 54 to 61c in these three processes. These figures are given on the basis of prices ruling in Germany. In plants of similar construction in the United States the cost of production is between 85c to $1 per 1000 cu. ft. In the United States only four plants of the newer type have so far been installed; two plants of 3530 cu. ft. per hour, one of 10,600 cu. ft. per hour, and one of 8000 cu. ft. per hour. Over fifty electrolytic hydrogen plants have been installed in the United States in the past five years, and the total amount of hydrogen now being generated by all processes per year in the United States is over 300,000,000 cu. ft.

The number of mechanical and chemical plants of the improved type erected in Europe up to the summer of 1914 (that is, up to the time when the war broke out) was 23, of a *total capacity of 3530 to 10,600 cu. ft. per hour. Three of these installations produce 200 to 880 cu. ft. per hour. All of these plants in Germany, Russia, Austria, Sweden, Holland, Italy and England were installed by Germans. Other large installations were negotiated for, but the writer is unable to ascertain facts regarding them due to conditions at present in Europe. No doubt Germany has increased its hydrogen-producing plants; likewise England, France and the other countries. New installations were undoubtedly required for the increased number of airships and observation balloons which have been built during the war.

*Average.

Modern Processes of the Technical Production of Hydrogen

Linde-Frank-Caro Process—A Physical Liquefaction

Water Gas Process

In this process water gas, consisting almost solely of carbonic oxide, CO, and hydrogen, is cooled and compressed until the carbonic oxide is liquefied, while the hydrogen still remains gaseous and can be drawn off. The apparatus consists essentially of a water gas plant and a plant for the separation of the hydrogen from the carbonic oxide gas.

The water gas is produced in the usual way by passing steam through incandescent coke, whereby the steam is decomposed, its oxygen forming carbonic oxide with the carbon of the coke, while its hydrogen remains free. Water gas, on the average, consists of hydrogen 50 per cent, carbonic oxide 40 per cent, carbonic acid 4 per cent, nitrogen 5.5 per cent, methane 0.5 per cent, with smaller proportions of oxygen, sulphuretted hydrogen, and carbon bisulphide.

The hydrogen is separated from the rest of the gases by compression and cooling. The boiling point of hydrogen, —253 deg. C., is much lower than that of the other constituents, that of carbonic oxide being —192 deg. C., and that of nitrogen —196 deg. C. On cooling compressed water gas to the temperature of liquid air,—193 deg. C., all of the constituents except the hydrogen are liquified. The hydrogen thus easily separated in the gaseous state is of a high degree of purity.

Before this separation by cooling is attempted the water gas undergoes preliminary treatment for the extraction of carbonic acid, which, if not removed, would block the narrow tubes of the rectifying apparatus. The removal of the carbonic acid gas is affected for the most part by compressing the water gas, in contact with cold water, up to a pressure of about 12 atmospheres. At high pressures water absorbs carbonic acid more easily than at atmospheric pressure, and hence the quantity of water required for absorption is reduced. The small residue of carbonic acid still remaining in the water gas is extracted by passing the latter through caustic soda.

This method of compressing water gas and cooling it by liquid air produces hydrogen 97 to 98 per cent pure. The residue consists of about 1 per cent each of carbonic oxide and nitrogen. Sulphur, dust and moisture are absent from the gas. The hydrogen leaves the apparatus under a pressure of 25 atmospheres, which is a considerable saving of power when cylinders have to be filled with gas under pressure. Two to four men can operate a plant, depending on its size. The plant is kept in continuous operation for about a week; it is then advisable to shut down the hydrogen separating section in order that all the worn tubes may be cleaned. A second unit of this section of the plant is kept in reserve for use while the first unit is being cleaned. To bring the entire plant into operation requires twenty to twenty-four hours.

The Contact Process—Known as the Lane or Iron and Steam Process

This process depends upon the well-known property possessed by incandescent iron of decomposing steam which is passed over it. The oxygen of the steam combines with the iron and the hydrogen is liberated. In the practical working of the process reduced iron ore is used which has the advantage over ordinary metallic iron of having a larger active surface and caking or fluxing less readily when heated.

The manufacture of hydrogen by this process proceeds in alternating periods, in one of which oxidized iron is converted by a cheap reducing gas to spongy iron, and in the other period steam is passed over the spongy iron with liberation of hydrogen. The cycle of operations proceeds continuously.

The essentials for the process are, therefore, iron ore, reducing gas and steam. Water gas is used as the reducing gas, and thus the plant required consists of a water gas installation and a special hydrogen apparatus.

The decomposition of the steam by the incandescent iron is effected in vertical iron retorts set in furnaces heated by producer gas. The retorts are charged with iron ore through the upper lids. Above the retorts are valves for regulating the passage through the retorts of steam and of reducing gas alternately and for taking off the hydrogen and the spent reducing gases. The latter, consisting chiefly of carbonic acid and steam, are either discharged into the open, through a shaft or are passed in to the retort furnaces, where any unconsumed constituents are utilized in heating the retorts.

The hydrogen gas thus produced passes from the retorts to the purifying plant. The first section of the latter is a condenser packed with coke sprinkled with water. From this condenser the hydrogen goes into two purifying vessels, worked in series, for the extraction of sulphur and carbonic acid. The gas then passes to a gasholder, from which it can be taken either for immediate use or to a compressing station, where it is filled into cylinders. The hydrogen finally obtained by this process has a specific gravity of 0.090=0.092; its purity is 97 to 98 per cent, the residue consisting of nitrogen, with 0.2 to 0.3 per cent carbonic oxide; furthermore, since the gas was cooled by contact with water it is saturated with water vapor.

A plant for producing 3500 cu. ft. per hour requires four workmen for each shift. Skilled labor is not essential. The iron ore which is used in the process can be kept in the retorts in uninterrupted operation for about two or three months. For efficient service the plant must be worked continuously, since it requires fourteen to twenty-four hours to start up from the cold.

The Rinker-Wolter Process—A Chemical Process for the Decarburation of Oil

This process is the result of a research which originally aimed at the production of an illuminating gas, but failing in this a highly efficient hydrogen-producing process was developed which ranks in importance with the iron-steam and the contact process. It is this process which is now being used to a great extent by Germany and Russia in their aeronautical work owing to the portability of the apparatus. Complete installations are set up on railway cars and carried from point to point as required. The plant takes up but little space, and is more easily supervised than the two other processes described above.

The process is one in which gas oil is used which is heated to 1200 to 1400 deg. C. and decomposed into its chief constituents, carbon and hydrogen. The plant comprises the special gas-making plant and purifiers. The gas-making plant consists of two producers which are charged with coke. There is a gas connection from the lower part of the first to the upper part of the second producer; near the furnace and clinkering doors of the producers are air inlets. These air inlets are fitted with valves having interlocking gears to prevent accidents arising from careless manipulation. The air required to raise the heats in the producers is forced through these inlets by a high-pressure blower.

When the producers have reached the requisite temperature, the blower is stopped and the blast valves closed. Oil is then pumped onto the coke in the first producer, through spraying nozzles which atomize it. It is converted into vapor by the hot coke and passes through the bed of hot coke in the second producer. In this way the vapor is converted into a permanent gas, which leaves the bottom of the second producer and enters a hydraulic main. When the air is in turn again blown in at the base of the producers in order to raise their temperature, the carbonaceous residue left by the oil on the coke is burnt and contributes towards the heating up of the producers. It requires one to one and a half minutes' blast to raise the producers to the proper temperature again. Thereupon oil is again introduced into the first producer.

The oil is preheated in order to render it sufficiently thin and mobile to pass through the spraying nozzle. For preheating the oil the exhaust steam from the turbine or engine used for driving the blower is utilized. Solid impurities are removed from the oil by pumping it from the storage tank through a filtering chamber.

The gas issuing from the second producer passes through a water seal in the hydraulic main, and there deposits the greater part of the sooty matter which is carried over mechanically. Clean water flows continuously into the hydraulic main, and the sooty water flows off and runs into a settling pit, having partitions which force the water to take a long and tortuous course in order to ensure the deposition of the solid matter.

The last two chambers of the settling pit are packed with coke, which acts as a filter and retains the last traces of impurities, so that the water may be run thence direct into any sewer or river. Soot is the only by-product of this process; the oil contains 80-85 per cent of carbon, of which the greater part is liberated; only a small proportion of carbon is found in the form of hydrocarbons and carbonic oxide in the crude hydrogen gas. Most of the liberated carbon is retained by the coke in the producers, and is later burnt by the air blast. A small proportion goes forward as soot in the gas, and is deposited in the hydraulic main and washer. The soot which collects in the settling pit when dried can be burnt under the boiler. The gas passes from the hydraulic main into a washer, where sprays of water remove the last traces of soot.

On leaving the washer the gas contains 6 to 8 per cent of carbonic oxide and sulphuretted hydrogen. The latter is removed in a purifier charged with bog iron ore. The carbonic oxide is extracted by hot soda-lime in the following manner: The gas passes from the iron oxide purifier into thin-walled retorts, set in a furnace which keeps the soda-lime with which the retorts are charged at a temperature of about 300 deg. C. At this temperature the soda-lime absorbs the carbonic oxide from the gas. The gas thus purified is cooled by passage through an atmospheric condenser and is then stored in a gasholder. The purity of the gas is from 97 to 98 per cent, the residue being nitrogen. The specific gravity is 0.087 to 0.090.

The operation of the plant is not difficult, and requires only moderate supervision. The producers can be heated up for use in one to two hours, and can be operated continuously for a few hours at a time or for days, weeks or even months.

An installation of this type may be either stationary or portable. The layout of a portable installation of this process, as now used by the governments of Germany and Russia, is as follows: The producers, with oil tank, oil pump, pre-heater and hydraulic main, are installed on one railway truck, and the purifying plant, including the washer and the final condenser, is arranged on a second truck. A gas holder constructed of balloon-fabric is carried on a third truck. The gas then passes from this holder to a compressor, placed on a fourth truck, by which it is compressed into steel cylinders.

Production of Hydrogen by Electrolysis.

In this process water is decomposed into its constituent elements, oxygen and hydrogen, by the aid of the electric current. One of the first commercial plants of this type to be erected in the United States was at Waverly, Newark, N. J., in 1911. The electrolytic generators, or cells, are of two types; the unit type is composed of an outer tank, which serves as the negative electrode, and a perforated inner tank made of special composition iron which serves as the positive electrode. The two electrodes are separated by means of a specially prepared asbestos diaphragm which divides the apparatus into two compartments. On top of the cover are the current terminals, two sight feed indicators and pressure equalizers, also a cup through which water is introduced into the cell from time to time.

As soon as the electric current is applied oxygen and hydrogen are seen to bubble through the indicators. The electrolyte is an aqueous solution of caustic potash or soda, which serves to make the water a good electrical conductor. In each cell about 1 gal. of water is decomposed per 24-hr. day, producing 76.8 cu. ft. of oxygen and 153.6 cu. ft. of hydrogen. The hydrogen is liberated on the walls of the outer tank (negative electrode), while the oxygen forms on the walls of the inner tank (positive electrode). The oxygen is carried up through suitable means to the oxygen equalizer, where it bubbles through water and passes on to the oxygen off-take pipe; the hydrogen similarly passes through the hydrogen equalizer and thence to the hydrogen off-take pipe. Each cell produces per kilowatt hour, 8 cu. ft. of hydrogen and 4 cu. ft. of oxygen. The current required per cell is 400 amp. at 2 volts. The purity of the electrolytic hydrogen is 99.8 per cent and the oxygen 99.6 per cent.

The cost of hydrogen by this process, disregarding the value of the evolved oxygen, is about ⅛ of a cent per cubic foot at current cost of 1c per kw.-hr. at the generator. For small or moderate size plants where low cost current is available the electrolytic process is preferable to any other for the production of hydrogen.

The attractive features of this process are: (1) The simplicity of operation; (2) the little attention required (not exceeding the cost of a few hours of one man's time per day); (3) cheap raw material (requires only 1 gal. of water to be added to each cell per day). The plant can be operated continuously for years without cleaning or overhauling; the process is clean and safe, and the cell produces gas as soon as the current is turned on.

Another variation of the unit type generator or cell is the bipolar generator recently placed upon the market. The type of generator is of the filter press type, but is not a modified filter press. While the form of this generator was early introduced in the art the bipolar type only resembles same in form. It is specifically designed for the electrolytic separation of water at the highest efficiency. This type of generator is to be commended where floor space is a consideration, as it is more compact than the unit type cell. The bipolar generator is made in two sizes. The 4 x 11 ft. has a rated daily capacity of 1,700 cu. ft. of hydrogen and 850 cu. ft. of oxygen. Size 5 x 15 has a rated 24-hr. capacity of 7,000 cu. ft. of hydrogen and 3,500 cu. ft. of oxygen. The above capacities are based on the use of caustic potash as electrolyte. Purity of the hydrogen is 99.8 per cent and oxygen 99.6 per cent. The generator may be operated twenty-four hours a day and 365 days in the year. The cost of the gases produced is about the same as in the unit type. The bipolar generator is as completely automatic as a high duty generator of this type can be made. Practically the only attention required in operation is in the maintenance of the water supply. Only part of one man's time is necessary.

Hydrogen in the Industries.

Hydrogen Employment in Quartz Glass.

Quartz glass, which has long been recognized as an important material in the manufacture of various articles employed in the chemical industry, was first produced in 1839 by Prof. Gaudin. Some of his quartz tubes and elastic threads were exhibited at the Paris Exposition in 1878.

In 1889, Boys, who recognized the possibilities of this remarkable substance, also succeeded in making small tubes and other articles.

However, little progress was made in the development of the quartz-glass industry until 1900, when Heraeus and Achendstone succeeded in making clear rock crystals large enough for practical purposes. The raw material is washed quartz sand containing 95 per cent silicic acid, which is melted by the oxy-hydrogen flames, and it is now possible to melt and to mold into almost any desired form as much as 50 lb. of quartz at a time.

One of the remarkable properties of the quartz glass produced by this process is its resistance to acids. Even boiling acids, with the exception of hydrofluoric and phosphoric, will not readily affect it. Quartz has the advantage of having a very low co-efficient of expansion, being about 1/17 that of the best glass suitable for chemical utensils and apparatus. The manufacture of quartz glass in the United States is only of very recent date.

Hydrogen in Balloons and Dirigible Airships.

Hydrogen, on account of its very low density, has the greatest lifting power of all gases, and is therefore used for filling balloons. The amount which a balloon will carry up, i. e., "its ascensional power," is the difference between the weight of the balloon itself with its contained hydrogen, and that of an equal volume of air. A liter of hydrogen gas has an ascensional force of 1.2 grams. The specific gravity of 98 per cent hydrogen is 0.087, which corresponds to a lifting power of 73.5 lb. per 1,000 cu. ft. Pure hydrogen has a specific gravity of 0.07, which corresponds to a lifting power of 75 lb. per 1,000 cu. ft.

Hydrogen for balloon purposes must be free from impurities that would injure the fabric, and should be dry. It is not necessary that the hydrogen be under pressure for inflating a balloon. It will readily inflate at atmospheric pressure.

Melting of Platinum.

In the melting of platinum the oxy-hydrogen burner is used exclusively. The temperature of the oxy-hydrogen is about 2,100 deg. C., whereas the melting point of platinum is 1,755 deg. C. The great advantage of this flame is that it contains no elements injurious to the platinum such as carbon. Illuminating gas, which was formerly used instead of hydrogen, was detrimental to platinum. The operation is carried out by passing oxygen and hydrogen at high pressure through an especially constructed oxy-hydrogen torch. The author devised a torch for this work several years ago, and it is practically the only platinum melting torch (oxy-hydrogen) used today in the United States by platinum smelters. The melting is best accomplished in a lime crucible. Oxygen and hydrogen at a pressure of 1,800 lb. per square inch in cylinders containing 100 and 200 cu. ft. with reducing valves and regulators are used.

Production of the Synthetic Ruby and Sapphire.

Practically all of the beautiful minerals of the corundum family are now being produced synthetically. The ruby and sapphire are the more important.

Alumina being the base of those precious stones, it remains only for the chemist to add the proper oxide to obtain the required colors and to fuse them together in the oxy-hydrogen flame. The ruby, for example, contains 98

per cent of pure alumina and about 2 per cent of chromic oxide.

The materials used are of the purest. It is absolutely essential that the material be pure, as otherwise the product obtained will be faulty and the color will be poor.

At a temperature of 1,000 deg. C. the material is calcined in a large oven and removed and reduced to a fine powder. The fine powder is then placed in the magazine of the oxy-hydrogen burner and forced down on a receiving base below the flame. The work at this stage is very delicate and requires most careful attention. All conditions must be regulated with mathematical precision, the rate of flow of the Al_2O_3 powder, the rate and pressure of the gases and the quality of the flame (1,900 deg. C.). With conditions properly adjusted the stone at first appears as a little stalk not larger than a pin head, which gradually grows in the fire. This stalk, as it grows taller, is broadened out by the manipulation of the torch by a skilled operator so as to form a small cone with the point down. The desired size obtained, the operator shuts off the gases and allows the jewel to cool. It is then broken from the base and is ready for cutting.

Electrolytic oxygen and hydrogen are used exclusively in this industry on account of the exceedingly high degree of purity of the electrolytic gases.

Hydrogenation of Oils.

In connection with the fat industry a very extensive use for hydrogen has developed. By the introduction of hydrogen into fatty bodies and oils of low melting point these are converted into hard fats of higher melting point. In other words, oils which are composed of unsaturated acids, such as oleic acid and their esters, will combine with hydrogen in the presence of a suitable catalytic agent, forming a saturated compound:

$$C_{17}H_{33}COOH + H_2$$
$$C_{17}H_{35}COOH$$

oleic acid + hydrogen = stearic acid.

The hard fats have a greater market value for the manufacture of soap, candles and oleomargarine. Fish oils, etc., lose their disagreeable odor in the hardening process. The application of hydrogen in the fat industry has brought about a great advancement. The process worked out on the following lines is known as hydrogenation.

The addition of the hydrogen to the unsaturated hydrocarbon of the soft fats is accomplished by exposing the latter to hydrogen under pressure at high temperature in the presence of a contact agent such as a mixture of finely divided clay with metallic nickel, copper or iron. This mixture is sprayed into a container made of boiler plate under a pressure of 4 or more atmospheres, the pressure varying according to the method of working and the catalytic agent employed. Into the container from the opposite end is introduced a current of hydrogen, which at a temperature of about 150 deg. C. readily combines with the oil or reduces the fatty acids. The hydrogen is added in excess in order to facilitate the conversion, but the surplus hydrogen, after being freed from oil particles, is returned to the storage tank.

The consumption of hydrogen varies according to the nature of the raw material and the hardness of the product. It is usually from 2,870 to 4,300 cu. ft. per ton. The fatty product run-off from the pressure vessel is an emulsion of the fat with the contact substance. The latter, after separation by centrifuging, is used over again.

The contact substance, according to the patent of Leprince and Siececke (Dr. Norman) is finely divided nickel or copper; according to Fokin, it is platinum, and according to Paal, palladium. With the last two conversion is effected at ordinary or relatively low temperature and at an exceedingly low pressure. Wherever these two rare metals in suitable form are used, many improvements in the process have lately been introduced. It is absolutely necessary to use hydrogen of a high degree of purity, since slight impurities in the gas will render the contact substance inactive. In the hydrogenation of cotton seed oil, 1 per cent of hydrogen by weight converts it into a fatty body of the consistency of lard. The product obtained is edible.

The Synthetic Production of Ammonia.

The discovery of the synthetic production of ammonia by Professor Haber of Karlsruhe a few years ago promises a very extensive use for hydrogen. It is of immense importance because it forms the basis of the well-known fertilizer, sulphate ammonia. When hydrogen and nitrogen are heated to 200 deg. C. in their combining proportions, under high pressure and in the presence of uranium as a contact substance, they unite to form ammonia. About 6 per cent of ammonia is produced, and by removing this a further conversion is effected. The yield can undoubtedly be greatly increased and the process accelerated by the selection of a possibly more suitable contact substance and the application of possibly more appropriate temperature and pressure. —Reprinted from Metallurgical and Chemical Engineering, Vol. XIV, April 1, 1916.

THE ELECTRIC ARC WELDING PROCESS IN THE BOILER SHOP.

By Robert E. Kinkead.*

The use of the arc welding process on boiler plate is one of the later applications of the process, and probably the most important application. In the repair of marine boilers arc welding has had a wide application, but up to the present time the application has been confined entirely to repair of boilers, as distinguished from the manufacture of the boiler. This is true also of the welding which has been done up to the present time on the hull and deck of the ship. The welding has been a means of repairing the boiler plates, rather than manufacturing them into boilers or hulls of ships. It is natural to assume that if the welded joint is good enough to hold in a repaired boiler it will be good enough in a boiler which has just been manufactured. The best explanation of why the process has not been used in ship building, as distinguished from ship repairs up to the present time, lies in the lack of information people have in regard to the process and the natural inertia of the insurance boards in taking up a matter of this kind.

In locomotive shops of the large railway systems of the country, the arc welding process has been used for a period of from six to eight years, and in many shops the process is used not only in the repairing of old boilers, but in the manufacture of new ones. The work in repairing old boilers may be grouped under the head of welding in flues, welding in tube sheet and welding cracks in the fire box. Also welding in new side sheets and repairing mud rings. In boiler shops now where the process is used, all new boilers have their flues welded before the boiler is put into service, and the number of new boilers having the back flue sheet welded into the boiler is constantly increasing. A few roads have welded the entire fire box with good results. So far as the difficulties arising from the application of the process to the welding of the whole fire box is concerned, they have been entirely solved by the users of the process who have gone so far as to weld large patches in the fire box, since this is by far the more difficult of the two operations.

The success of the arc welding process in the welding of

**Engineering Department, The Lincoln Electric Co., Cleveland.*

Quality = *Guaranteed* = Quantity

Write US About Your Acetylene Supply

Commercial Acetylene Railway Light and Signal Co.

ATLANTA, GA.
AURORA, ILL.
BOSTON, MASS.
BOUND BROOK, N. J.

80 Broadway, New York City

PEOPLES GAS BUILDING
CHICAGO, ILLINOIS

EAST DEERFIELD, MASS.
TORONTO, ONT.
SAN FRANCISCO, CALIF.
MOBERLY, MO.
W. BERKELEY, CALIF.

marine boilers and locomotive boilers has lead naturally to its application to all kinds of stationary boilers and tanks made of boiler plate for boiler service as well as other kinds of service to which tanks in general are subjected. Very little has been done up to the present time in the application of the process to stationary boilers for the reason that few electric arc welding plants are in use, although there is an enormous field for the use of the apparatus in connection with the repairing of stationary boilers in large manufacturing districts.

It should be understood that a boiler shop, as a general proposition, will manufacture anything made out of boiler plate. The name, boiler shop, does not necessarily mean that the shop manufactures steam boilers. In fact, a number of boiler shops, probably 60 per cent of the boiler shops of the country do not manufacture steam boilers. A boiler shop is usually run in connection with a machine shop and a good percentage of the work consists of riveting boiler plate to castings. The following is a list of some of the products of the boiler shop, besides steam boilers, common today:

Foundry tumbling barrels.
Cylindrical revolving driers for cement work and chemical plants.
Tanks, vats and flues for chemical plants.
Vats for breweries.
Industrial cars.
Dump cars.
Clam shell buckets.
Bessemer converter shells.
Open-hearth furnace port coolers.
Annealing pots spelter tanks.
Transformer housings.
Oil refinery equipment.
Sugar refinery equipment.
Cotton mill equipment.
Flues, tanks and containers for gas plants.
Special bodies for automobiles.
Concrete mixers.
Tank cars.
Steel gondolas.
Steel box cars.
Gasoline tanks.
Tanks for agricultural uses.
Feed water heaters.
Power plant accessory equipment.
Wagon tanks for distribution of oil.
Wagon tanks for the distribution of roof paints, asphalt, etc., such as used by the Barrett Mfg. Co.
Fan and blower cases.
Hydraulic accumulators.

The above equipment is practically a job of riveting together boiler plate or boiler plate and castings. Where a piece of boiler plate is riveted to a gray iron casting, there is no field for the electric arc welding process, since the riveting joints will be much stronger and more reliable than a welded joint. Where boiler plate is riveted to boiler plate, however, the arc process has the advantage of giving a better joint at lower cost.

In order to get a comprehensive view of the application of the welding process to boiler shop practice, it is of interest to trace the plate through the boiler shop. The plate as it comes from the manufacturer, has been sheared as nearly as possible to the size required for the particular job on which it is to be used. If it is not the proper size, however, the plate is moved to the shear, where it is handled by from two to four men, depending upon the size of the plate. From this point, the plate goes to the layout men where it is set up on horses, and the layout man lays out the rivet holes in accordance with the requirements of the blue print from the drafting room. The layout man is usually a man who has had experience in the drafting room as well as general experience in the boiler shop. He is one of the highest paid men in the boiler shop, and draws at the present time in the Middle West, from 40 to 50 cents an hour. After the layout man has laid out the holes, he marks them with a center punch and passes the plate on to the punch man. Two men operate the punch, one steadying the plate, and the other controlling the punch. These men are paid from 25 to 30 cents an hour. From the punch the plate goes to the bevel shears where the edges are beveled so that the edge of the plate can be caulked after the plate is in place. In practically all of the work in the boiler shop the edges of the plate are caulked. Two men operate the bevel shears, and they are paid from 25 to 30 cents an hour each. From the bevel shears the plate goes to the bending rolls, if it is to be bent. Two men are required on the bending rolls, and they are paid from 30 to 35 cents an hour. From the bending rolls the plate goes to the erectors. These men are experienced boiler makers, and they assemble the plate according to blue print and bolt it in place ready for the riveting gang. These men are paid from 35 to 40 cents an hour and on large tank work, work in gangs of two to four men. After the job has been erected, the riveting gang goes to work on it. The riveting gang is made up of three men; one boiler maker, one bucker, who is a second rate boiler man or an apprentice and does nothing but buck the rivets. The third man is the heater who heats the rivets in a small forge fire and passes them up to the bucker. Or, in some cases, actually takes the rivet and puts it in the hole. After the riveting gang comes the caulker who caulks the edges of the plate and in important work caulks the rivets.

In boiler shop practice the riveting gang forms the base unit of all calculation; in other words, the speed at which the riveting gang works governs the speed of all other operations in the shop. A typical boiler shop organization is as follows:

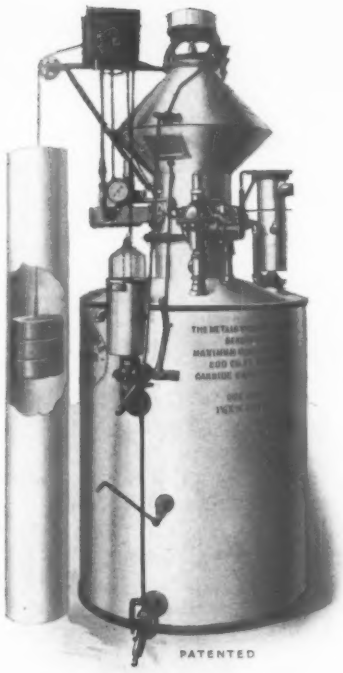
One foreman.
Three riveting gangs.
Two erectors and one helper.
Two men on the bending rolls.
Two men on the bevel shears.
Two men on the punch.
Two layout men.
One oxy-acetylene burner.
One blacksmith and helper.
Three general utility helpers.

This organization constitutes a well balanced organization for the manufacture of boiler shop products of a rather complicated nature; that is, there is very little repeat work, not more than a dozen tanks or jobs of one kind being done.

In order to get at the cost of riveting a joint, therefore, it is necessary to determine the speed at which the riveting gang will work, and charge for the time of the other men in the shop in the correct proportion. The speed of the riveting gang depends upon the size of the rivets, upon the shape of the job, upon the size of the job, upon the accuracy with which the layout was made and the holes punched and upon the general spirit prevailing in that particular shop. It is pretty generally agreed among boiler makers and foremen in boiler shops that on straightway riveting where there is no difficulty from half blind holes or the necessity of using a drift pin and no handling of the job is necessary, the riveting gang can put in

80 ½-inch rivets at 1½-inch pitch in $\frac{7}{16}$-inch plate in one hour. This is at the rate of 800 rivets in a ten-hour day.

On ½-inch plate, 60 ¾-inch rivets, spaced at 2¼ inches can be put in, in one hour.



Do You Believe In Preparedness?

Then Why Not Prepare For An *Independent* Supply of Acetylene?

Every welding shop and every manufacturing plant using the oxy-acetylene welding process should have an independent and efficient supply of acetylene gas. Why depend upon shipments of tanked acetylene, sometimes from a distance, when it is possible to generate your own acetylene **safely** and economically right in your own plant? You can't afford to pay retail prices for acetylene, and wait for delivery, when it is possible for you to generate your own gas at **wholesale** prices. When you need acetylene you usually want it in a hurry—the job must be done at once. With our generator your problem is simplified.

This generator costs more—and there's a reason, in fact several reasons. Consider these factors:

1. It's the best constructed generator on the market, **exceeding** the requirements of the National board of Fire Underwriters.
2. Acetylene gas of a high quality is generated at a low cost—less than ½ the cost of tanked acetylene.
3. Will operate uniformly at all times under supervision of common labor. This generator is "fool proof." No complicated mechanism—but simple safety devices that prevent accidents. No question of "didn't know 'twas loaded" here.
4. Every generator is built like a battleship—strong and efficient. All seams are welded, every part thoroughly tested.
5. The carbide used is 1¼x⅜ inches in size and yields about 15 per cent more gas than fine carbide. Generators are made in two sizes, Model B, 100 pounds for small plants and Model C, 200 pounds carbide capacity, for large plants. May be installed singly or in units and added to as required.
6. This is a stationary generator, but gas may be piped anywhere. No chance of tipping machine over, or disturbing normal operation of machine. An acetylene generator should not be moved.

There are many other reasons why you need this generator. Why not discuss the matter with us. Send for illustrated catalog.

Portable Outfits

There are many uses for portable welding outfits. Our No. 1 Portable equipment is thoroughly practical with ample capacity for any ordinary welding or cutting job. We think our torches are among the best designed and constructed tools on the market. Before you buy get our prices.

We Teach Welding

We have one of the best equipped welding shops in the west and employ 20 to 30 welders. Work of every description is constantly passing through the shop. We like to have our customers spend a few days in our plant—we believe the assistance we can and do give is worth the time.

The Metals Welding Co.

Cleveland, Ohio, U. S. A.

On ¾-inch plate, 40 ⅞-inch rivets, spaced at 2½ inches, can be put in in one hour.

The above speeds are attained in certain classes of work, and for a short period. The average speed for all classes of ship building work, considering the different speed of different gangs, is probably 20 per cent under the figures given above. On a series of observations made by the writer in several boiler shops, where general boiler work is done, the average speed was found to be 30 to 35 per cent below the speeds given above. This was due perhaps to the fact that it was not straightway riveting as is the case in ship building and to the fact that the men were paid by the hour rather than by the number of rivets as is the case in most ship building. For the purpose of estimation, the writer considers a speed of 25 per cent less than the maximum speed of riveting given above a very fair basis for estimation. This speed can be attained on the repeat work of the boiler shop, but cannot be attained on jobs of a very complicated shape.

In order to compare the cost of riveting with the cost of welding we may take the amount of work accomplished under given conditions by the riveting gang, analyze the cost of the work and compare it with the cost of doing the same work with the arc welding process. Taking the thickness of the plate as ⅜ inch, spacing the rivets at 1½ inches, the size of the rivets at ½ inch in diameter, we can safely estimate that the riveting gang will put in 60 of these rivets in one hour, under ordinary shop conditions. The analysis of the cost is as follows:

Boiler maker's time, one hour.....35c
Rivet bucker's time, one hour.....25c
Rivet heater's time, one hour.....20c
One caulker's time, ½ hour.....18c
One layout man's time, ½ hour.....20c
Two punch men's time, ¼ hour.....
Two erector's time, ⅓ hour.....
Two roll men's time, ⅓ hour.....

Total labor .....

Length of riveted seam, 7 feet 6 inches.
Pounds of rivets required, 3.6.
Cost of rivets, 10.8 cents.

Power required to drive pneumatic hammer and calking tool approximately 10 kilowatt hours.

Investment per riveting gang, in air compressor with motor drive, storage tanks, distributing piping system, air hammers, and other machines, $650.

In order to get a comparative cost of the arc welding process, we will analyze the cost of doing the same work; namely, making a seam 7 feet 6 inches long; which is a lap joint, welded inside and out. The following is an analysis of the cost:

One operator at 35c per hour for 1¼ hours.....
No bucker required.
No heater required.
One man with a chipping hammer, ½ hour.....18c
One layout man, ¼ hour.....10c
Two punchers, ⅛ hour.....
Two erectors, ⅛ hour.....10c
Two roll men, ⅓ hour.....20c

Total labor $1.10

Pounds of electrode required, 2.5.
Cost of electrode, 12.5 cents.
Kilowatt hours required to run the welder, approximately 5.

Investment in welding machine for one man, $760 to $860.

(Continued on page 42)

Just Published

Autogenous Welding and Cutting

By THEODORE KAUTNY

Translated from the German by the author and James S. Whiteford.

157 pages, 5x7½. 133 illustrations
$1.00 (4/2) net, postpaid

A translation of a standard German work giving in compact form for ready reference the important elements of the process. Every effort has been made to avoid the use of confusing technical terms and to give such information as will help the individual welder to a more thorough understanding and appreciation of the art.

CHAPTER HEADINGS

I. Autogenous Welding Flames. II. Acetylene Manufacture and Apparatus. III. Oxygen Manufacture and Apparatus. IV. Gas Mains and Fittings. V. Autogenous Welding Burners. VI. Autogenous Cutting Burners. VII. Autogenous Welding of Iron. VIII. Repairs of Gray Cast Iron. IX. Welding of Sheet Iron. X. Manufacture and Repairs of Boilers. XI. Manufacture of Cylindrical Vessels. XII. Manufacture of Rectangular Vessels and Miscellaneous Articles. XIII. Manufacture and Installation of Large Pipes and Conduits. XIV. Manufacture and Installation of Gas and Water Pipe. XV. Construction of Pipe-Shaped Apparatus. XVI. Welding of Copper. XVII. Welding of Aluminum. XVIII. Welding of Nickel and Other Metals. XIX. Conclusion.

THE WELDING ENGINEER
608 S. Dearborn Street, CHICAGO, ILL.

Finding the idea you want—*Quickly!*

If you can't use an idea in THE WELDING ENGINEER in January, perhaps it will repay you many times the subscription price next July.

Yet when you *can* use that idea, are you always able to find the article *immediately*—or do you have to rummage for it in forgotten places, often to find that it is lost? Keeping your back copies in a *usable* form is only one of the advantages of

THE WELDING ENGINEER

If your associates *must* borrow your WELDING ENGINEER, hand it to him in a binder; he can't forget to return it. Again, this new binder will keep your copies free from dust and germs—with no torn and mutilated pages.

With this Binder you can convert your pile of magazines into a valuable ready-reference business library—you have at your finger-tips the actual knacks, the methods *proved* by the experiences of other welders.

Each "Arnold" binder, made especially for us, has a capacity of 12 issues—nearly 500 pages of ideas and suggestions from the "other man." Bound in the latest scratch-proof, dirt-defying, reverse green Buckram cloth; solid metal back. To insert magazine, merely place one of the rods between any two pages and slip it over the binding posts—no ripping or cutting necessary. Neatly stamped with THE WELDING ENGINEER logotype.

Better send for your Binder TODAY—before *this* important March issue is mislaid. Furnished AT COST—Price, $1.00. *Two copies,* $1.75.

THE WELDING ENGINEER, 608 S. Dearborn St., CHICAGO

TRADE NEWS

The International Acetylene Association will hold a meeting in New York City July 25th, 26th and 27th. J. M. Morehead, Peoples Gas Bldg., Chicago, is president of the association and A. Cressy Morrison, same address, is secretary-treasurer.

A metal turning of 0.55 per cent carbon steel, indicating a depth of cut of ¾ in. and a feed of ⅛ in., was noted in the possession of Carl G. Barth, consulting engineer, Philadelphia, at the recent meeting at Ann Arbor of the Taylor Society. The chip was cut with a stellite toll at a speed of 85 ft. per minute.

Isaac H. Levlin, chief engineer and chemist of the International Oxygen Company, has resigned to give his time to chemical research. He will specialize in the electrolytic field.

The Improved Appliance Company, 455 Kent Avenue, Brooklyn, N. Y., have issued a circular describing brazing tables, burners, etc.

The Waterhouse Welding Co., Boston, Mass., has issued a new catalog describing welding, cutting, decarbonizing equipment, etc.

The International Oxygen Company, 115 Broadway, New York, calls attention to the fact that, although the total generating capacity of the I. O. C. oxygen-hydrogen apparatus installed to date is many times the aggregate of all other electrolytic apparatus for the same purpose, there is not one instance of an explosion of gases due to defects in I. O. C. equipment. The company credits this exceptional record to the fact that, in the design and construction of its apparatus, every known precaution is taken to secure the utmost purity of gases, to prevent gas leakage, and to eliminate possibility of the intermingling of the oxygen and hydrogen in an explosive mixture.

The Superior Oxy-Acetylene Machine Company of Hamilton, Ohio, are casting a high silicon cast iron welding rod 3 feet long, this being the longest welding rod that can be practically cast. Manufacturers of welding apparatus and supplies report brisk business. The prospects for a good summer and fall are very good. Welding rods in some grades are scarce, but on the whole supplies are easier to obtain than it was thought possible some weeks ago.

Classified Advertising

MEN WANTED.

WELDERS WANTED—Two men experienced in aluminum and brass work. Give experience in detail. Recorder, U. S. Naval Aeronautic Station, Pensacola, Fla.

WELDER—First class all around with reliable habits and work qualities, to take care of jobbing work. Will allow very liberal percentage on work. Could keep a first class machinist busy when not welding. Give particulars. Medina Machine Co., Medina, Ohio.

WELDER—Experienced welder wanted. Give experience and full information. Zouri Drawn Metals Co., Chicago Heights, Ill.

FOREMAN WELDER—Would consider application from experienced welder capable of taking charge of welding shop employing about thirty welders. Address W & B Mfg. Co., care The Welding Engineer.

WELDER—Have opening for good all around welder. Auto parts, grate bars, mill work etc. This is health resort very favorable for tuberculosis. Excellent opportunity for man just infected or has some one in family with trouble. Will pay customary wages. The Shelley Tool Co., Inc., Saranac Lake, N. Y.

POSITIONS WANTED.

WANTED—Position as welder. Eight months' experience. Can weld most anything. J. M. Hish, Shelbyville, Ill.

WANTED—Am machinist and welder in auto and general repair shop. Would use part time selling equipment and supplies. Would like to hear from manufacturers. C. R. Hammond, 130 N. 23rd St., Salem, Oregon.

WANTED—Position as salesman by experienced welder and machinery salesman. J. F. Thomas, New London, Wis.

Become a Jobber

Inquiries and orders for welding machines and supplies have come to us through this ad. Many of these firms ordering material and supplies have to wait a long time and pay excessive charges for their goods.

We are therefore compelled to turn these inquiries over to jobbers in the states from which these orders come, who can ship the goods wanted quickly and at low rates.

The proposition is a good one and one which will make money for the jobbers who will handle the goods. Write us regarding the selling of welding supplies.

Become a JOBBER

WELDING MATERIALS

720—115 South Dearborn Street
CHICAGO

Repair Aluminum at Low Temperature

Imperial Aluminum Solder

EASY TO USE RESULTS GUARANTEED

Tested tensile strength 8,500 to 11,780 lbs. per sq. in. In use by largest welding concerns, auto manufacturers, auto-body builders, etc.
Trial order with complete instructions, three dollars.
Agents wanted throughout the United States.

Imperial Specialty Sales Co.
1777 Broadway, NEW YORK

Buy the SUPERIOR

Oxy-Acetylene Welding Supplies, Welding and Cutting Equipment—Welding and Cutting Torches, Oxygen and Acetylene regulators with gauges.
Orders filled promptly upon receipt of same. All makes of equipment repaired.
Write for free samples of supplies and catalog.

Superior Oxy-Acetylene Machine Co.
Hamilton, Ohio
Long distance phone 474-R Night call 1276-R

WELDING PHOTOGRAPHS

We make a SPECIALTY of photographing welding jobs

Chicago Architectural Photographing Co.
140 So. Dearborn Street Chicago, Illinois

(Continued from page 40)

It is to be noted from the above analysis that the labor cost item in the manufacture of boiler plate construction by riveting is approximately 75 per cent greater than in the case of the welded construction.

The amount of power required for riveting is double the amount required for welding. The investment required by the arc welding apparatus is somewhat higher than in case of the riveting machinery, but this, of course, is offset by the lower operating cost.

The above analysis has been made with reference to jobs which can be either riveted or welded and it shows rather conclusively that it is considerably more expensive to rivet a joint than it is to weld it.

The strength and durability of the welded joint is greater than the same properties of the riveted joint in the case analyzed above. The welded joint is 100 per cent efficient or as strong as the original plate which is a strength impossible in a riveted joint.

There are a number of jobs which occur in ordinary boiler shop practice in which it is considerably more expensive to rivet a joint than it is to weld it and where it is impossible to get the strength in the joint by the riveting process that is possible by welding. One of such applications is that in which a boiler plate is stiffened or braced by the use of angle iron structures. This necessitates the bending of the angle iron or the joining at right angles of angle iron sections. Now if the angle iron sections are simply brought in contact with each other at right angles a great deal of the stiffening effect produced, otherwise, is lost, whereas if the angle irons are welded together a much greater stiffening effect is accomplished. In this case riveting is impractical and welding in the forge fire is very expensive owing to the tendency to distort the angle irons and causes difficulty when it comes to riveting.

Another case in which the welding has a number of advantages over the riveting is where a plate section is so large that a single plate large enough to take care of it cannot be obtained. Such occasions occur in the manufacture of tube sheets for various kinds of strainers, dyers, and water heaters. Riveting such a joint makes an awkward and expensive piece of construction, where welding the joint and planing it down to the thickness of the original plate makes a neat as well as serviceable and inexpensive joint. Mistakes in the drilling and punching of holes in plates can be corrected by the use of the arc welding process to a much better advantage than if the old method of filling up with the rivets and clipping off the heads is used.

In certain cases of flanged heads and other difficult construction, the use of the butt welded joint eliminates a great deal of difficulty. In case a flanged head is to be welded with a butt joint, the welding should be done after the plate is flanged rather than before, otherwise, the welded joint will have to be heated and the metal in the weld forge before the flanging can be done. Where instead of flanging the angle iron construction is used, the arc welding process provides an easy means of joining the end of the angle iron after it has been riveted into place.

In the substitution of the welded joint for the riveted joint, it is recommended that in plate of $\frac{1}{8}$ inch in thickness and over, wherever possible a joint be made as a lap joint rather than a butt joint. The amount of lapping should be at least four times the thickness of the plate. The work can be held together preparatory to welding by the use of bolts and after the job is welded the bolt holes can be filled up and chipped off. The use of a hammer for the purpose of hammering the metal welded on after the weld is completed in order to "pack the metal in" should be discouraged. This is of no benefit and a positive harm may come to the metal from this practice. The chipping tool can be used, however, to dress the welded joint up to make it neat in appearance. In case the welded joint is to be subjected to a pressure test and it is found that there are small pin hole leaks, these leaks can be satisfactorily repaired, either by chipping out a small amount of metal at that point and filling in new metal or by a small amount of peaning with a center punch at the point at which the leak occurs. Where heavy plate is being welded and more than one layer of metal is put into the joint the operator should always be required to brush the thick layer of oxide from the metal with a stiff brush commonly known as a blasting brush or a painter's wire brush. This is done so that the metal throughout the whole weld will be as free from slag and oxide as possible. Neglect of this important practice may mean a leaking or spongy weld. On pressure tank work where a homogenous weld free from blow holes is an absolute necessity, the operator should hold as close an arc as possible and the speed of the work should be sacrificed in order to use a comparatively low current and consequently get the metal into the weld in the best possible shape.

Most of the welding in the boiler shop should be done with the metal electrode process, although on very heavy plate the carbon arc can be used to advantage in speeding up the operation. As is the case in metal electrode work 150 amperes per operator represents the capacity required in the welding machine. Probably in the general practice of the boiler shop, the majority of the work will be done with $\frac{1}{8}$-inch electrode using some 150 to 175 amperes; although a considerable percentage of the work will be done with $\frac{5}{32}$-inch electrode using 130 to 140 amperes. There is some work where $\frac{1}{4}$-inch electrode can be used to advantage with 175 to 190 amperes. As a general proposition, however, the 150-ampere unit is of ample capacity for any work encountered in the boiler shop. The total amount of welding capacity required by a given shop depends largely upon the character of its output. While it probably will be sometime before the boiler shop without pneumatic riveters and riveting gangs will be the general rule, there are boiler shops at the present time where the number of welding operators is equal to the number of riveting gangs and in a few cases the welding operators are in the majority.

In approaching a boiler shop man on the subject of welding, it is always well to pick out several specified jobs and show him what can be done on those specific jobs rather than to try to convince him of the advisability of going into the welding business wholesale at first. As a rule, the man who has been born and bred a boiler maker has a good many misgivings about the welding process even though he has risen from the position of ordinary boiler maker to foreman of the shop. The boiler maker is naturally prejudiced against the welding process because it throws him out of a job, but the man who will be interested in the proposition is the man who has to sell his product in competition with other people who are making and selling the same thing, since any advantage in cost and selling price that he can get means more money for him. The man in the engineering department or drafting room where the jobs for the boiler shop are laid out usually is friendly toward the process, because he of all other men can see the possibilities for its application and besides this, it makes his work considerably easier because before the layer out in the boiler shop can lay out the rivet holes from a blue print, the drafting room must do all of the engineering work and furnish the blue print. If the product is to be welded, the drafting room needs only to lay out a few holes so that the job can be held together until the welding operator gets to it. In other words, it is to the advantage of the man in the drafting room or engineering department to have an arc welding machine in the place, if for no other reason than to correct mistakes and fill up the holes in the plates which that department has had punched by mistake.

SUPERIOR OXYGEN

FOR

Welding and Cutting Metals, Hospital, Medicinal and Mine Rescue Work. Decarbonizing Automobile Cylinders, etc.

SUPERIOR OXYGEN PLANTS AND WAREHOUSES

New York Chicago, Ill. St. Louis, Mo. Defiance, O. Pittsburgh, Pa.
Fort Wayne, Ind. Cleveland, O. Detroit, Mich. Toledo, O.
Joliet, Ill. Kansas City, Mo. Fort Smith, Ark.
Louisville, Ky. Dayton, O. New Orleans, La.
San Antonio, Texas

Other oxygen may be good

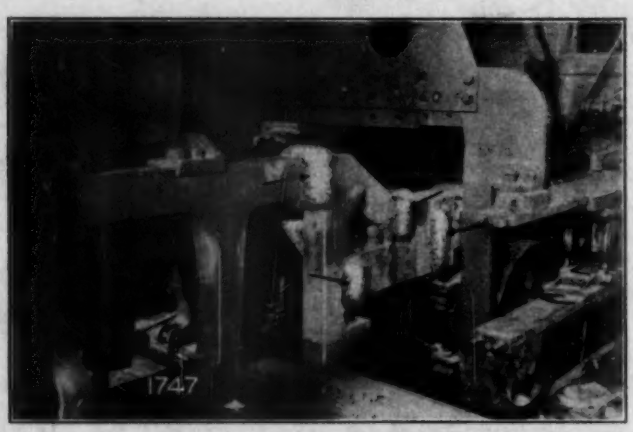
— *but* —

Ours is Superior

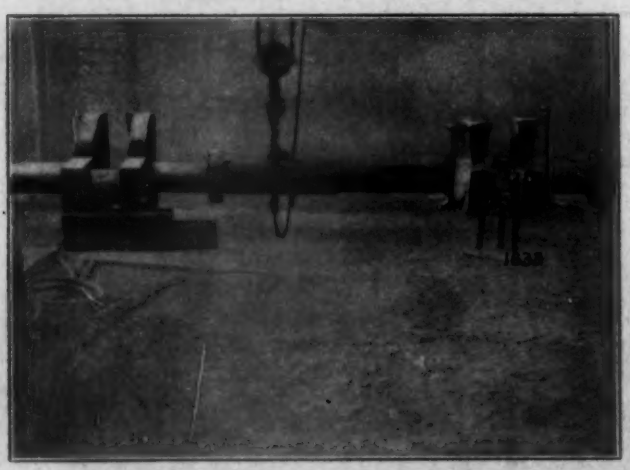
A trial will convince you. Write us

New neck cast on to large roll made with the aid of Thermit and having the pods cast in at the same time.

Large bevel gear on which two new teeth and crack have been repaired.



Four Thermit welds on locomotive frame on the Missouri Pacific Railroad, made without removing the frame from place.



New crank pin welded in by the Thermit Process.

We Are Prepared

To Undertake at a Moment's Notice the Handling of Any Serious Breakdown

Breakage and wear in steel mills and other manufacturing plants has been greater at this time than ever before.

We have been called upon by so many large iron and steel companies recently to make quick repairs to broken rolls and pinions, connecting rods, shears, crank shafts, locomotive frames, and many other sections, the breakage of which often means a serious delay in the operation of the plant, if not a complete shut-down.

Wire or telephone our nearest office and we will proceed at once for arranging the shipment of materials and send an expert to supervise the repair.

We have an eighty-page pamphlet devoted exclusively to this class of work, which is known as pamphlet No. 1779, and tells how the work is executed and how you can do the work yourselves.

Goldschmidt Thermit Co.

William C. Cuntz, General Manager

Equitable Bldg., 120 Broadway
New York

329 Folsom Street, San Francisco 7300 South Chicago Avenue, Chicago
103 Richmond Street, W., Toronto, Ont.